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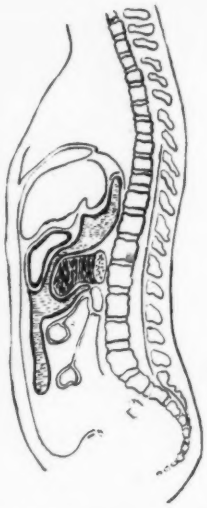

Fig. 1. Tumor of pancreas. Stomach in front, colon below.

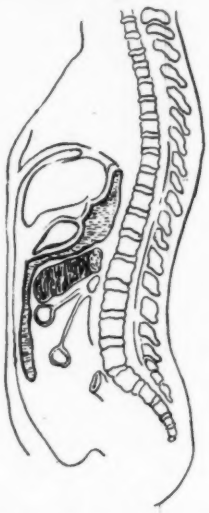

Fig. 2. Tumor of pancreas pushing forward between the posterior layer of the great omentum and the transverse mesocolon.

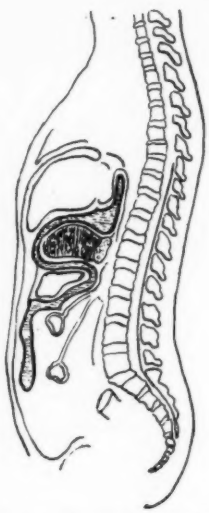

Fig. 3. Tumor of pancreas. Stomach and colon both below.

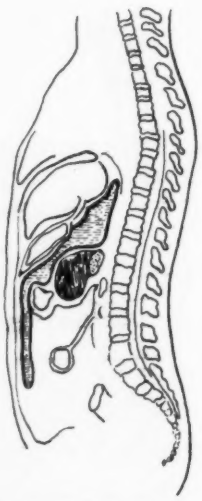

Fig. 4. Tumor of pancreas. Stomach and colon in front of it.

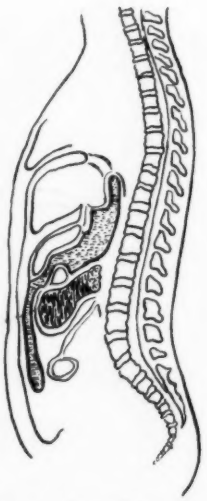

Fig. 5. Tumor of pancreas. Stomach and colon both above it.

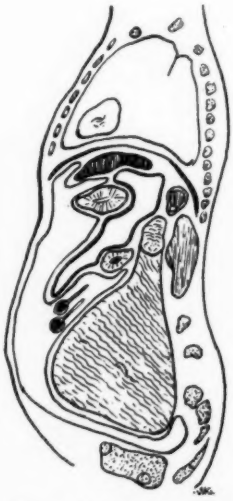

Fig. 6. Tumor, cyst of pancreas. Stomach, colon, and small intestine above and in front of it.

(Figures, 1, 2, 3, 4, and 5 from Robson and Moynihan.)

Pancreatic Cysts and Pseudocysts.—A. Primrose.

SURGERY, GYNECOLOGY AND OBSTETRICS

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PANCREATIC CYSTS AND PSEUDOCYSTS

REPORT OF A CASE OF TOTAL EXTIRPATION BY AN EXTRAPERITONEAL METHOD

BY A. PRIMROSE, C.B., M.B., C.M. (EDIN.), TORONTO, ONTARIO

Professor of Clinical Surgery, University of Toronto; Surgeon, Toronto General Hospital

CYSTS of the pancreas are comparatively rare affections. The number of operations upon abdominal viscera, the world over, is now so enormous that even this rare condition has been encountered many times and individual cases being of special interest have been reported in the literature. It is, therefore, possible to study an extremely varied series of cases since Virchow described retention cysts of the pancreas in 1863.

The classification suggested by Robson and Moynihan in 1903 was as follows:

1. Retention cysts;
2. Proliferative cysts—
   Cystic adenoma,
   Cystic epithelioma;
3. Hydatid cysts;
4. Congenital cystic disease;
5. Hæmorrhagic cysts;
6. Pseudocysts.

To this list must be added dermoid cysts as the result of a recent communication by Judd in which he describes a cyst arising in the body and tail of the pancreas containing hair and one tooth. With this addition, however, the classification of Robson and Moynihan still holds good.

The association of acute and chronic pancreatitis with the formation of these cysts is well established, and, in turn the relationship between infection in the gall bladder and bile ducts as an etiological factor, direct as to pancreatitis and indirect as regards cyst formation, must be taken into account. In fact, it is asserted that the most common cause of cyst is chronic interstitial pancreatitis due to pressure on the ducts of the contracting connective tissue (Cammidge). It is suggestive that biliary colic and jaundice have been recorded as symptoms preceding cyst formation. Such a case was reported by McPhedran as long ago as 1897. Castronuovo reports a cyst of the tail of the pancreas in a man 60 years of age, a syphilitic who had hepatitis and perihepatitis with moderate icterus lasting 6 weeks. Ten months later he removed the cyst along with a necrosed portion of the pancreas. Ballin and Saltzstein have recently reported a case which clinically showed pancreatitis, cholelithiasis, cholecystitis, and subsequent to cholecystectomy the development of a pancreatic cyst, containing 4 quarts of brownish thin fluid. The gall bladder was removed because it was filled with stones. Some confusion at the moment exists regarding the correct method of utilizing our knowledge concerning the relationship here established. Thus Judd has noted the fact that cholecystectomy has effected a cure in certain cases of pancreatitis. He explains the sequence of events as follows: After cholecystectomy the bile dams up in the extrahepatic ducts causing dilatation; as this continues

the walls of the ducts hypertrophy until finally the resistance offered by the sphincter of Oddi at the entrance to the duodenum is overcome and a continuous flow of bile and pancreatic secretion, into the duodenum, ensues. On the other hand McWhorter argues in a logical fashion that the removal of the gall bladder, reducing as it does the pressure within the bile ducts, produced by the expulsive force of the muscular wall of the gall bladder, must effect a condition in which the pressure is not sufficient to overcome the resistance of the sphincter of Oddi. The result may cause regurgitation of the bile into the pancreas and the production or aggravation of pancreatitis. While recognizing the results obtained by Judd, we must consider the possibilities suggested by McWhorter, particularly in view of the case reported by Ballin and Saltzstein, and we are inevitably forced to the conclusion that Archibald is right in arguing, from his experimental and clinical evidence, which is most convincing, that prolonged drainage of the common bile duct in cases of pancreatitis is essential to effect a permanent cure. This may be accomplished with or without cholecystectomy. Koerte has reported a case in which after providing drainage of a pancreatic cyst he endeavored to establish drainage of the bile ducts by a cholecystenterostomy, the anastomosis being accomplished between the gall bladder and the jejunum. In this case the gall bladder at the time of operation contained 35 stones.

In many instances of pancreatic cyst formation there is a history of trauma. Kellock remarked on the frequency with which a kick from a horse on the abdomen was followed by this condition. Duschl records the case of a soldier who had a laceration of the duct of Wirsung as the result of a sharp blow over the stomach. This resulted in the formation of a cyst from the head of the pancreas. Not an unusual course of events is that described by Murray:

> A boy, age 9, was run over by a delivery wagon. This caused a slight laceration of the pancreas producing hæmorrhage and the escape of pancreatic juice into the lesser sac of peritoneum. This was followed by a mild form of peritonitis resulting in the closure of the foramen of Winslow. The lesser sac became distended and a pancreatic cyst thus developed. The lad was operated upon 5 weeks after the accident, and recovered.

There are a number of instances in the literature of pancreatic cysts occupying the lesser sac of peritoneum. Walker reports an unusual case of a man suffering sudden acute abdominal pain after severe muscular effort. Three weeks subsequently a cyst, containing 2 pints of pancreatic fluid, was found in the lesser sac of peritoneum.

Koerte proposed the term pseudocyst for a fluid tumor found in more or less close proximity to the pancreas but not originating in the substance of the gland, the most frequent examples being those of effusion into the lesser sac of peritoneum as the result of injury to the pancreas. There is a great deal of confusion in recent literature in the use of the term pseudocyst; thus Koerte himself in a paper published in 1911 speaks of a pseudocyst as developing in a case of pancreatitis. However he believed that a chronic interstitial pancreatitis might result from injury. Others reserve the term for a pancreatic cyst having no epithelial covering, containing fluid surrounded by a wall of connective tissue formed within the pancreas or in contact with its surface, the contents being in part at least products of pancreatic secretion (Opie). The term pseudocyst has been restricted by Willis and Budd to those resulting from trauma. These have otherwise been called apoplectic cysts in which, as the result of the injury to the pancreas, hæmorrhage occurs and ferment may escape. The cyst wall is composed of dense fibro-elastic tissue. It is true that many cysts of the pancreas are lined by cylindrical epithelium but, on the other hand, the wall may be entirely devoid of epithelium. Koerte asserts that in true cysts the epithelium is often destroyed by the destructive effects of the pancreatic juice laying bare the underlying connective tissue. He remarks upon the remarkable fact that the epithelium is digested and the underlying connective tissue remains, while on the other hand we would consider the best defense against digestion to be the intact epithelium.

The existence of the products of pancreatic secretion in the cyst contents has been frequently noted. On the other hand

numerous instances of true cysts are on record where no ferments are found. Opie states: "The presence in cystic contents of one or more enzymes resembling those of the pancreas was formerly believed to give proof that a cyst had its origin in the pancreas. Not infrequently one or perhaps all of these enzymes are absent in the contents of a pancreatic cyst, whereas fat-splitting, diastatic, or proteolytic enzymes are found in fluids not derived from the pancreas."

To establish the diagnosis of a pancreatic cyst, the presence or absence of ferments would, therefore, appear to be of relatively little value; one must rely chiefly upon the anatomical relationship of the cyst to the pancreas. The occurrence of pancreatic tissue in the cyst wall would of course be conclusive, while the presence or absence of an epithelial lining is of little or no value in diagnosis.

The cyst may be unilocular or multilocular; they may be single or multiple. Bolt has recorded a case of polycystic disease of the pancreas. In this case the right kidney was also polycystic. Koerte has described a multilocular cystadenoma and Speese reports an unusual condition of a proliferating cystadenoma of the pancreas with extension to the abdominal wall 10 years after drainage of a pancreatic cyst. Hydatid cysts of the pancreas are recorded in the literature. An interesting case of this nature was recorded by my former colleague, the late Dr. George A. Peters, who succeeded in reaching the cyst by an incision through the loin and in effecting cure by evacuation and drainage. Parlavecchio obtained a cure in hydatid cyst of the tail of the pancreas after marsupialization and drainage.

The case which I have to record is a pancreatic cyst discovered in a woman immediately after the birth of her child at full term. There was no previous history to indicate its presence; it was of large size, invading the pelvis, and was mistaken for an ovarian cyst. Total extirpation was done with complete recovery. Following is a complete history of her case:

Mrs. B., age 32, a strong healthy woman was delivered of a child at full term on January 28, 1912. Prior to delivery the size of the abdomen was such that her physician in attendance thought it was a twin pregnancy. This belief was not dispelled when on the birth of the child, the abdomen remained large. It was soon discovered, however, that a large cyst filled the abdomen extending from the costal margin above, downward into the pelvis. This cyst was diagnosed as ovarian in origin and the writer was summoned to remove it, 6 weeks after delivery. On my arrival at the farm house the patient had already been prepared for operation, but, through the sterile towels one readily detected a large abdominal cyst. It was dull on percussion immediately above the pubes and in the flanks. It appeared somewhat elongated and did not present the characteristic spherical appearance of an ovarian cyst: its long axis was somewhat oblique from above and in the left, downward toward the center of the pelvis. The umbilicus was absolutely flat and showed no puckering, possibly this condition was produced by the great distention during pregnancy.

On opening the abdomen I exposed the cyst, which extended far down into the pelvis. I passed my hand below it and found it had no pelvic connections whatever. A layer of tissue lay over the cyst wall proper which proved to be the posterior parietal peritoneum. The small intestine lay above it and it soon became obvious that one had to deal with a retroperitoneal cyst which had developed downward and forward behind that portion of the parietal peritoneum which lies below and to the left of the attached portion of the mesentery of the small bowel. The right kidney and the spleen were in normal position. I incised the single layer of peritoneum which lay as a superficial covering over the cyst wall proper. The edges of the opening which I had thus made in the posterior parietal peritoneum were carefully stitched by continuous catgut suture to the edges of the opening which I had made in the anterior parietal peritoneum when I cut through the abdominal wall at the first. By this means I marsupialized the peritoneum, and by so doing I completely shut off the general peritoneal cavity while, at the same time, the cyst, partially bared of its peritoneal covering, lay in the bottom of my wound. I now proceeded to enucleate the cyst from its bed. This, to a certain point, was accomplished without much difficulty, but the posterior part of the cyst wall could not be reached. I, therefore, punctured the cyst with a large sized trochar and cannula, and drew off 5 litres of pale, chocolate-colored fluid, of the consistence of pea soup. I now continued the enucliation of the flaccid cyst wall: as I approached its base above and to the left it became more dense and more firmly connected, so that many vascular bands required ligation. Finally I narrowed it down to a pedicle containing an artery slightly larger than the radial and a vein as thick as one's forefinger. This pedicle lay to the left on a level with the body of the first lumbar vertebræ and was attached to the tail of the pancreas. I first separated the artery and ligated it; the vein with some adjacent tissue was then similarly

secured. The stump was sewn over by continuous catgut suture. In the cavity which remained I palpated and identified the left kidney. When the oozing from the cavity ceased I secured a drainage tube in place and otherwise closed the wound by silkworm-gut sutures through skin, muscle, and aponeurosis.

The operation lasted one hour: immediately after her return to bed the patient's pulse was 80 per minute and her general condition excellent.

The cyst wall was subsequently examined by Dr. O. R. Mabee and was found to be composed of fibrous tissue without evidence of any more specialized type of tissue.

The contents of the cyst were analyzed by Professor J. B. Leathes, who reported as follows: "The greenish, more or less opaque, fluid contained diastase in fair amount, but no evidence of trypsin or any protolytic enzyme nor of lipase. No urea was found but a small quantity of sugar by reduction test."

Dr. M. K. Dillane, who referred this patient to me, made careful inquiry into the previous history of the patient. As a young woman she suffered four or five times a year from "inflammation of the bowels," each attack lasting a day or two. She has been free from these for the last 8 or 9 years. She had acute rheumatism 10 years ago. She has never had any other illness.

It is now 9 years since I removed the cyst. She has enjoyed excellent health, and on December 27, 1915, 2 years and 9 months after the operation, she was delivered of a child at full term. There had been no discomfort during gestation and the parturition was normal in every way. The patient has remained perfectly well and no weakness has developed in the abdominal wall.

The treatment of a pancreatic cyst by marsupialization has been advocated and carried out many times. In this operation the cyst wall, after exposure, is sutured to the anterior abdominal wall, preferably to the skin, and the cyst is then opened and drained. In the case which I have just described, however, the marsupialization was accomplished by suturing an opening in the posterior parietal peritoneum to an opening in the anterior parietal peritoneum. The cyst wall was now attacked and was dealt with entirely outside the peritoneal cavity which had been shut off from the field of operation by the method described. As far as I have been able to discover, this method of uniting the opening in the posterior parietal peritoneum to the opening in the anterior parietal peritoneum has not hitherto been suggested or described in the treatment of pancreatic cysts. Hitherto it has been the wall of the cyst which was sutured in the process of marsupialization while in the method suggested and successfully carried out by me the peritoneum alone is sutured and the cyst wall is not included in the process.

Complete extirpation of a pancreatic cyst was first done by Tozeman in 1882 and since then has been successfully accomplished many times. Such cases have been described by Koerte, Willis and Budd, McCann, Moschcowitz, Roic, deFrancisco, Alexandrow, Gobell, Chand, and others. Mason records a remarkable case in which he removed three-fourths of the pancreas along with a cyst which had contained 4 quarts of fluid. Koerte quoted Gobell as stating in 1907 that the mortality after total extirpation was 10.7 per cent and after incomplete partial extirpation 55.5 per cent. The much higher mortality in the latter cases was accounted for by the insurmountable difficulties encountered in separating the cyst from neighboring organs (stomach, transverse colon, etc.) and from great blood vessels, and the damage done in the attempt to do so. In endeavoring to free a cyst the colon has been torn: adhesions to the stomach, duodenum or liver have precluded the possibility of enucleation. The portal vein has been found firmly embedded in the cyst wall (Robson and Moynihan). On the other hand the cyst may present no adhesions of moment: such was the case in the instance reported in this paper.

There are two factors to be considered regarding the anatomical relations of the cyst: first its point of origin from the pancreas, and second the relations established by the cyst as it enlarges and invades the abdomen. Regarding the first point it may be stated that a cyst may arise from any portion of the gland, head, body or tail. The tail of the gland is the most common seat of origin. The connection with the pancreas may implicate a wide area of the gland or it may be reduced down to a narrow pedicle. As to the relations established as the cyst enlarges one may state that occasionally it comes forward between the liver and stomach; it may push the stomach immediately in front of it; it may come between the stomach and the transverse

colon; it has been found between the two leaves of the transverse mesocolon, or again it may pass out below the transverse colon. The relationship established in my case must be unusual, in fact I have not been able to discover a similar instance. The cyst developed below and to the left of the parietal attached portion of the mesentery of the small intestine. On opening the abdomen the small intestine, transverse colon, and stomach all lay above the cyst. It is not surprising that a cyst developing from the tail of the pancreas should develop in the direction here indicated, the normal line and extent of attachment of the mesentery of the small bowel would readily permit it. The original diagrams of Robson and Moynihan (Figs. 1 to 5), which have been so frequently copied by other authors, are faulty in that they represent the possibilities of spread in the middle line only. The diagrams are those of a vertical sagittal section passing through the center of the bodies of the vertebræ. I have added a diagram (Fig. 6) taken from a frozen section of the body to the left of the spine and I have incorporated in this diagram the development of the cyst in my case, arising from the tail of the pancreas and spreading downward below and behind the small intestine. There are numerous instances on record in addition to my own where a pancreatic cyst has been mistaken for an ovarian cyst (Robson and Moynihan, McCann, and others).

The most common method of treatment hitherto employed for pancreatic cyst has been incision and drainage, with or without a preliminary marsupialization of the cyst wall. Robson and Moynihan refer to a remarkable case reported by Hagen in which the operator could reach the cyst only through the stomach. He divided first the anterior wall of the stomach and then the posterior wall. The cyst behind the stomach was then incised. He introduced his finger into the cyst and, displacing the stomach somewhat to the right, he succeeded in bringing a part of the cyst wall in contact with the parietal peritoneum. To this it was sutured and here drainage was established. The incisions in the stomach wall were sutured. The patient, a child of 13, recovered. Veller (quoted by Kerr) gave a record of 13 cases operated upon by evacuation and drainage in two stages; all the patients recovered. Drainage through the loin, as in Peter's case, has been recommended by some surgeons. Drainage of the ordinary type of pancreatic cyst usually results in a cure but a troublesome fistula may persist for a long period and the secretion therefrom may be of a very irritating character (McPhedran, Koerte, Walker, etc).

Pancreatic cysts have been found at all ages from young infants to individuals of three score years and ten. The most common period according to statistics of Koerte is in the third and fourth decades. Telling and Dobson describe a case in an 11 months old child, and these authors quote Railton as having recorded a case in an infant of 6 months. It would appear that they occur about equally in men and women. It is noteworthy that in several instances they have been discovered in women after confinement (McCann, Mayo). The significance of the relationship here is not apparent: in my case the cyst had attained large proportions and yet its existence was not suspected until immediately after the birth of a full-time child.

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THE DIAGNOSIS AND TREATMENT OF SOME COMMON INJURIES OF THE SHOULDER JOINT[1]

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AS the peculiar manifestations of injury and inflammation in the shoulder joint seem conditioned by its peculiar structure, it may be permissible first to review certain anatomical and mechanical conditions existing in it as a preliminary to the consideration of the clinical manifestations.

1. The shoulder joint in the quadruped acts as a weight-bearing joint, but in the course of evolution it has ceased to bear weight and in the upright position must support the weight of the arm—in the adult probably amounting to 10 or 15 pounds. It, therefore, has become transformed from an asset to a liability. This considerable weight for the great part of the time drags more or less vertically down upon the joint because in the upright position the humerus is, most of the time, at the side, while the elbow and wrist are much in action in daily life and carry much less weight. The important practical point is that the shoulder supports a very considerable weight and is a purely hanging joint.

2. This weight is not supported by the capsule to any large extent, but by the muscles, mainly the biceps, the triceps, coracobrachialis, and deltoid. If these are paralyzed the humerus drops away from the acromion, and in the cadaver if these muscles are divided the humerus falls away about an inch. In no other joint in the body do ligaments fail to hold the joint in place against gravity.

3. The joint possesses the greatest range of motion of any of the joints and is movable in all directions, and at no one time is any considerable part of the head of the humerus in contact with the shallow glenoid cavity. Extremes of motion are checked by capsular and ligamentous tension and support by the tendons of certain muscles.

4. The shoulder joint is not firmly connected with the skeleton, but is mounted on a movable base, the scapula. Abduction of the arm depends on fixation of the scapula, and before the movement can be made, the trapezius and rhomboids, pectoralis minor and serratus magnus must hold the scapula firmly, and when even the trapezius is paralyzed, abduction of the arm is slight or absent even if the deltoid is good. This relation of the scapular muscles to all shoulder motion is important, and is the dominating consideration in estimating the effect of ankylosis of the joint, because although ankylosis in abduction is the position of choice with a movable scapula, if the scapula is immobile for any reason, fixation in abduction is a calamity.

5. The relation of certain muscles to the joint structures is most intimate, and most important to remember. The tendon of the subscapularis is closely merged with the front of the capsule, and between it and the capsule at one point is a bursa communicating with the joint. The long head of the biceps passes through the joint capsule encased in a synovial tube. The supraspinatus tendon passes across the upper part of the capsule, to which it is adherent, to be inserted into the greater tuberosity. The infraspinatus tendon passes across the posterior surface of the capsule, and the deltoid muscle is separated from direct contact with the joint only by the subdeltoid bursa, and the tendons mentioned.

6. The subdeltoid or subacromial bursa is about the size of a silver dollar, but this is variable and does not generally communicate with the joint, but it lies very close to it, its floor being separated only by the tendons of the short rotators. Its base is formed by the tuberosity of the humerus and the tendons of the rotators, and its roof is attached to the acromion and acromioclavicular ligament. Its relation with the joint structures is, therefore, most intimate. The bursa under the subscapularis has been mentioned,

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there is also one under the infraspinatus tendon and several others of minor importance.

7. The final point of surgical importance is the muscular balance. We have two very powerful muscles—the pectoralis major, and the latissimus dorsi, which pull the arm in to the side by a direct straight pull. We have one large and one smaller muscle—the deltoid and supraspinatus, which pull the arm away from the side, both of the latter working under unfavorable conditions of leverage, and dependent even then on the fixation of the scapula by the trapezius, and other muscles. Moreover, the first action of the deltoid must be to lift the arm vertically until the head of the humerus impinges on the upper part of the joint before it can become an abductor; the supraspinatus, is however, an abductor from the start as can be seen from its line of pull. In short, the effect of muscular balance is to favor an adducted position of the arm.

Briefly then, we have a weight-carrying, loose ball-and-socket joint, kept in contact in large part by muscular action, and this joint is most intimately connected with important tendons and bursæ which enter into its structure. Injuries must be complex in most cases from the purely geographical association of many different structures.

It is not necessary to do more than to define the cases under consideration for every clinic is haunted by them, and every surgeon sees them constantly, the picture being familiar to all. After a wrench or overuse of the shoulder, perhaps after exposure to cold, or in connection with some slight systemic infection, the shoulder becomes painful and irritable, it soon becomes impossible to abduct the arm to its full extent actively, and pain is likely to be felt at the insertion of the deltoid at the outer aspect, especially in the later stages. Active or passive rotation becomes restricted and uncomfortable, but forward motion persists after the other motions have disappeared. The arm becomes especially painful at night, and it wakes the patient when he turns on his side. While the stiffness remains incomplete, the two most painful motions are to fasten the suspender buttons or skirt bands at the back, and to fasten the collar at the back of the neck. As the affection progresses the arm becomes stiffer in the more acute cases and the only abduction allowed is that obtained by the motion of the scapula, and the patient learns to hold the elbow up and close to the side with the other hand. Atrophy of the arm and shoulder muscles occurs. A most uncomfortable condition results, and there is little tendency to spontaneous improvement, so that the patient, and sometimes the surgeon become discouraged.

DIAGNOSIS

In many localities the diagnosis of subdeltoid bursitis is the usual one made in these cases, and I quote Codman's view, who has been a pioneer in the study of this subject: "More patients seek hospital treatment for lesions of the subacromial bursa than for all other lesions including tuberculosis and fracture taken together." And again the following quotation may be made: "I believe that it will be found that most minor lesions of the shoulder joint involve the bursa and few involve the true joint." The very great frequency with which this diagnosis is made, in some parts of the country at least, leads to the question, for reasons which will be given, whether it does not belong to a class of stock diagnoses often made by surgeons on what would seem to be insufficient evidence. A "torn ligament" is often diagnosed where the evidence would seem to warrant only the term sprain, yet the explanation that the ligament is torn seems to the patient to warrant discomfort for months, really often only the result of a badly treated simple sprain. The term "neuritis" is very carelessly used by surgeons for the explanation of all sorts of pain, and is very popular with the laity who make the diagnosis themselves with great freedom, imposing on a surgeon, who sees much of the surgery of chronic cases, a large burden in the way of explanation. "Dislocation of the sacro-iliac joint" is a very popular diagnosis in many parts of the country, but so far X-ray and pathological evidence of its existence, except from great trauma, is wanting. "Dislocation of the semilunar cartilage of the knee" is an easy

explanation of slow and obscure knee-joint injuries. In place, therefore, of using the diagnosis of subacromial bursitis as the routine one in these injuries we will do better to look further and see if a more exact and descriptive diagnosis cannot be reached. For this purpose it is important that any data which we have for identifying and localizing injury of this region should be used with a view of obtaining accurate information.

In many shoulder-joint injuries, so many structures are involved that it is impossible to identify any one as the especial one involved, and it may be necessary in these cases to use the time-honored term "sprain" in speaking of the acute cases, and in the chronic cases to resort to the old diagnosis of periarthritis, which is at least descriptive and a better guide to treatment than the assumed diagnosis of the involvement of some special structure, if such diagnosis cannot be established by adequate clinical evidence. But an accurate anatomical diagnosis can only be made when the injury is confined to special structures, and we must use the anatomical data in our possession for this localization.

Sprain. A sprain may be due to a stretching or tearing of the capsule or ligaments, to injury of the synovial membrane, or to the extravasation of blood into the tendon sheaths or any of the structures surrounding the joint. The grave after-effects of sprain or periarthritis, as one may call it in the later stage, are also most manifest in the limitation of abduction and rotation, and the irritating effect of the weight of the arm as already mentioned.

Muscular strain. If a definite muscle suffers from strain it will be painful if it is actively contracted, and still more painful if the voluntary attempt to contract it is resisted, or if it is passively stretched, and the pain is most likely to be referred to either the origin or the insertion of the muscle. If any fibers have been ruptured, there is likely to be also acute pain on pressure at the spot of rupture and varying amount of hæmorrhage at the same site. If many muscular fibers are torn and the muscle is superficial, a prominence may occur at the site of the rupture when the muscle is put into action. This prominence cannot be found, and the signs of hæmorrhage are less clear in rupture of the deeper muscles.

The most common muscles about the shoulder joint to be strained are the deltoid, the biceps, and the internal rotators, while the external rotators are rarely seriously injured in this way. In the case of the deeper muscles, the diagnosis must be made chiefly by impairment of function and pain on use as described. It must be remembered, however, that in the involvement of the shoulder muscles, passive motion in a certain direction may be allowed, while the active motion is painful. This is particularly noted in abduction when the surgeon may often lift the arm from the side without pain, but if the patient attempts to hold it in this abducted position severe pain is felt at the insertion of the deltoid muscle.

To make an accurate diagnosis of muscle strain, one must have fresh in his mind the action of the most important muscles which may be mentioned. The *deltoid* raises the arm from the side, but it is assisted in so doing by the supraspinatus muscle, so that limitation of abduction does not mean necessarily that the deltoid is affected, because tenderness at the insertion of the supraspinatus muscle will also limit abduction. It must be remembered also in making the diagnosis of deltoid strain, especially in the later cases, that immediately following the injury muscular atrophy begins, and of all the muscles supporting the arm the deltoid suffers most, and the pain so commonly experienced at the insertion of the deltoid in shoulder-joint injuries is an instance of this. That is to say, strain of the deltoid, unless detected immediately after the accident, may be the result of the drag of the weight of the arm on the deltoid and complicate the picture.

The biceps. The function of the biceps is three-fold: to flex the forearm on the arm, to supinate the forearm, and to raise the whole arm forward from the frontal plane of the body. To detect injury of the biceps tendon one starts with attempted flexion contraction of the muscle with the arm at the side and the movement resisted. The

movement of supination of the forearm should cause pain at the site of the long head of the biceps. Tenderness over the biceps tendon should be found in the bicipital groove of the humerus, with which may be associated in this location swelling and soft crepitus when the biceps is used, detected either by the finger or the stethoscope.

Internal rotation. The important muscles producing this are the pectoralis major and the subscapularis. The pectoralis major is accessible to palpation throughout its course, and pain in internal rotation combined with local tenderness in the pectoralis major would establish injury of that muscle. Pain in internal rotation, when there is no local tenderness in the pectoralis cannot, however, be assumed as certainly establishing injury to the subscapularis muscle, because the latter is so closely associated with the anterior part of the capsule of the joint and the bursa which separates it from the base of the coracoid process that a resisted attempt at internal rotation might result in pain, not only from the involvement of the subscapularis, but also from injury to or inflammation of the capsule in that region. If local tenderness to palpation is not present in the pectoralis major muscle, and internal rotation is painful it may be assumed that the injury is to the subscapularis tendon or the anterior capsule of the joint or to both.

External rotation. External rotation is produced by the infraspinatus, aided by the teres minor. The infraspinatus is one of the most important protections to the joint, supporting it from behind, but is not commonly affected by muscle strain. It would be detected along the same lines indicated.

What has been said about muscular strain applies equally well to the strain of their tendons and in the latter case it may be possible to detect the crepitus of tenosynovitis.

Synovitis. Proceeding in the matter of the differential diagnosis of shoulder-joint injuries, we come next to the condition of acute synovitis, which occurs here as in the other joints, but is less frequent in a typical form than in the knee, for example, for the reason that the capsule plays so small a part in the support of the arm and limitation of arm movements, and so large a part is taken by muscles. For this reason muscular injuries in the shoulder joint are more prominent than elsewhere, and purely synovial injuries less frequent.

In acute synovitis or arthritis or involvement of the shoulder joint in arthritis deformans, rotations are the first movements to be limited, followed closely by abduction. Pain on pressure is usually acute over the most superficial part of the joint below and outside of the coracoid where the synovial membrane is most accessible, and there is some sense of deep swelling. In this condition also, in its later stages, pain is frequently found referred to the insertion of the deltoid muscle. If acute symptoms continue, it passes into a subacute condition, which may be described as arthritis or periarthritis, in which the symptoms as described as characteristic of the acute stage persist.

Rupture of the supraspinatus insertion. After a fall and sometimes after severe exertion, as in golf, symptoms are felt in the shoulder joint consisting of a severe reaction in the joint associated with inability to abduct the arm and tenderness over the tip of the shoulder. Attempts to raise the arm from the side are excessively painful and felt in the shoulder, and if the condition is not recognized and remedied, the disability in the shoulder still goes on but diminishes until all that remains of it is an irritable arm with inability to abduct without discomfort, and a dragging sensation frequently referred later to the outer side of the arm. Two types of this injury may occur. In the first the supraspinatus tendon may be ruptured in part or wholly, in which case the diagnosis is not always clear, but more frequently it pulls off a piece of bone from its insertion, which is perfectly evident in the X-ray by the appearance of a detached piece of bone, and the cavity in the bone made by its detachment can generally be detected. This injury was particularly emphasized by Codman, who frequently found the tendon frayed out in dissecting room subjects, and in operation on the subacromial bursa. The relation of the tendon and the bursa is so

intimate that a partial rupture of it would be very likely to be associated with reaction in the bursa.

Bursitis. Up to this time nothing has been said of the involvement of the bursæ of the shoulder joint which are numerous and important. One or two of them communicate directly with the shoulder joint and must obviously be involved in any inflammation of that joint.

The subdeltoid bursa is in close contact with the structures of the joint and our attention must next be directed to that. The diagnosis of subdeltoid bursitis is so frequently made that it seemed worth while to go over the whole literature of the subject with a view to seeing what symptoms were described as characteristic to that particular injury, because in my own experience I saw so many cases diagnosed as subdeltoid bursitis that really on investigation and in their subsequent history seemed to be clearly lesions of the character described above, and not bursitis at all. It was impossible to find in this very extensive literature any symptoms essentially diagnostic of this condition, except in those cases where loose bodies were felt in the bursa, or where the X-ray showed either calcification in it, or a dense cloud in the soft parts limited to the region of the bursa, sometimes seen in an X-ray taken with a soft tube.

There is no question whatever that this bursa is from time to time injured and inflamed, but in certain of those cases the involvement of the bursa may be secondary to joint involvement. Tenderness over the bursa and the fact that limitation of abduction was partial in bursitis, and total in arthritis were dwelt on as characteristic but it is obvious that either or both of these may exist in the conditions described above. The sign described by Dawbarn where tenderness over the bursa exists but disappears when the arm is abducted and the bursa slides under the acromion may be of use, but as the arm is very early fixed at the side, abduction is impossible. It needs only a glance at the anatomy to see that this bursa must share in extensive inflammations of the joint, and in injuries and inflammation of the tendons of the supraspinatus and infraspinatus and subscapularis.

This diagnosis is an important one, because on it may depend the question of operative interference which obviously should not be undertaken without very definite signs of the existence of the condition, and undertaken then only with a very definite idea of what is to be accomplished by operation.

TREATMENT

The treatment of injuries of the shoulder joint has almost defined itself by what has been said in speaking of the anatomy and mechanics of the joint. There are two essential requirements:

1. The arm should be abducted from the side and held there in order to take off the weight from the capsule and supporting muscles, and to relieve pain.

2. The abducted position is necessary to counteract the pull of the two strong muscles —the pectoralis major and the latissimus dorsi, which if not antagonized will become adaptively shortened, hold the arm to the side, and promote the occurrence of adhesions in the adducted position, and these adhesions are a real menace as they may occur in the capsule, periarticular tendons, and bursæ.

The use of a sling is unsatisfactory treatment and is responsible for a good deal of the after trouble that we have in treating these cases. It takes off part of the weight of the arm from the supporting structures, but favors the occurrence of adhesions in the adducted position and adaptive muscular shortening. It is, of course, perfectly good treatment to use a sling in the treatment of very light cases which are doing well, but as soon as any limitation of abduction appears or if it is originally present, to continue the use of a sling is to bid for trouble. The use of a platform splint, unsightly and conspicuous as it is, is the only efficient treatment for moderate and serious injuries of this type in the shoulder joint. The splint may be made of wire, plaster of Paris, or any other material; it should hold the arm at a right angle to the long axis of the body, and the elbow should be if possible in the frontal plane. In very acute cases, however, it will be impossible

to put the elbow as far back as this at first, and a position in front of this will then be preferable. The elbow should be flexed at a right angle, and theoretically the forearm should be vertical, as internal rotation as well as adduction should be antagonized. But in the majority of cases, perfectly satisfactory results are obtained if the forearm is horizontal. This splint is not worn at night except in very severe cases, and if it is to be worn at night, plaster of Paris would be better than the wire. Light massage and measures to stimulate the circulation are apparently useful as soon as the acute stage is over, followed by active exercises for the abductors, external rotators, and scapular muscles, but early massage often excites a reaction, while electric light baking of the shoulder can be generally tolerated and improves the circulation.

No common injury that we meet, except possibly injuries to the spine, is so badly treated as injuries of the shoulder joint, and one relief that these patients receive from operations on the bursa is perhaps because following these, the arm is fixed in an abducted position.

Adhesions. The majority of cases, when they consult the surgeon, have already acquired adhesions in the adducted and inwardly rotated position, the arm is exceedingly painful and intolerant of manipulation, and unless something is done there is no prospect of immediate improvement. As under these conditions massage is not tolerated and nagging passive movements are irritating, the best course to pursue, in cases where practically no abduction is allowed, is to fix and support the arm in a position as much away from the side as possible without discomfort, by the use of a sling for support and a pad between the elbow and the body to secure abduction, the size of which pad should be gradually increased.

It will be found in nearly all cases that the patient or someone connected with him is trying to stretch the arm and keeping it constantly irritated. The use of fixation under these conditions will result even in the worst cases in quieting the symptoms, after which the real treatment may be undertaken by gentle passive stretching, given without anæsthesia, at first every second day, by the surgeon. Small gains may be obtained which are held by increasing the abduction of the arm. A platform splint may then be put on which will maintain only a few degrees of abduction, and this angle of abduction should be from time to time increased, but it is never wise to increase it to the point of irritating the joint, and the level of the arm should always be a little short of the maximum obtainable. As the irritability quiets down, more and more force may be used in the manipulation, and the angle of the splint increased, but it must rest entirely with the judgment of the surgeon in his manipulations not to use enough force to excite a reaction which does not quiet down within 48 hours. Much reaction would mean an increased danger of adhesions, and every second day is at first often enough. Light adhesions will be felt to rupture during such manipulation from time to time. In addition to manipulation in abduction, external rotation must be restored and the arm must be brought back until the elbow is in the frontal plane of the body. After each treatment the arm should be put back on the abduction splint and massage continued. The process is a very slow one and continues for weeks in bad cases.

If progress is checked by coming up against an obstacle that cannot be overcome by the use of moderate force, or if it is impossible to give the time to the treatment, manipulation under anæsthesia becomes advisable, but *not* during the acute stage. After the symptoms have quieted down sufficiently to warrant it, the patient is anæsthetized fully, and unless severe resistance is encountered the arm should be put through its full range of movement in abduction and outward rotation, and the manipulation should finish with the hand behind the head and fixed in this position until the patient is well out of anæsthesia. This position is obtained by Brickner by tying the wrist to the top of the bed, the head of which is raised by blocks. The patient should begin at once to move the arm voluntarily, even if painful, as it restores his confidence and is much safer than passive

motions. If a very severe resistance is encountered in manipulation, it should be abandoned for the time being, the arm fixed in as much abduction and outward rotation as possible, and the remainder of the process conducted by manipulation by stages under anæsthesia, gaining what may be safe each time, fixing the arm in the best obtainable position, and when full correction has been obtained, active movements, even if painful, should be gone through by the patient, but passive movements are to be avoided when painful.

Operative treatment. There are two conditions requiring operation in connection with injuries of the shoulder joint. If the supraspinatus muscle has been torn away, carrying with it a piece of bone, the arm should be placed in an abduction splint and an X-ray taken with the arm fully abducted. If the X-ray shows the fragment of bone in place, the treatment should be continued in this position until time has been given for the fragment to unite. If it is not then in satisfactory position, it is advisable that an operation should be performed. The operation of choice is the one described by Robert Jones. An incision like the cut of a sabre is made straight across the shoulder through the acromioclavicular articulation which is divided, and continues posteriorly below the spine of the scapula at the origin of the acromion process. A gigli saw is passed beneath the root of the acromion and the process divided from the spine of the scapula. The deltoid is now turned outward and downward giving complete exposure of the floor of the bursa, and the fragment is fixed in its proper position by a pin. The acromioclavicular joint is sutured and the acromion falls back into place where it has been separated, and the arm is immobilized in abduction, and there is little likelihood of displacement.

The other condition demanding operation is that in which a chronic bursitis of the subdeltoid bursa has been clearly established, which has not yielded to the measures described in speaking of the treatment of shoulder-joint injuries, or where the calcification of the walls of the bursa is clearly demonstrated. In this case the bursa is opened by an incision through the deltoid muscle exposing the roof of the sac. If this is opened the floor of the bursa is exposed and the tendons of the short rotators are seen just below the floor. Adhesions are broken up, villous masses removed, and calcareous deposits identified and scraped away or dissected out. If there is reason to suspect an injury to the tendon of the supraspinatus, its sheath should be incised in its length and the tendon repaired. The dissection out of the whole bursa is impossible as it is attached to the tuberosity of the humerus and to the acromion above, and routine attempts to dissect out the bursa in slight cases should be discouraged.

Irritable arm—false neuritis. Any consideration of injuries to the shoulder joint would be incomplete without mentioning one very troublesome condition which must be constantly seen by all surgeons, and which has not, apparently received much attention, which may best perhaps be spoken of as a painful or irritable arm, and is exceedingly common in practice. In certain patients, particularly nervous and overworked women, symptoms wholly out of proportion to the cause follow slight injury and overuse to the shoulder joint, or may appear without known cause. The injuries are more often slight strains or excessive use of the muscles in persons with poorly developed shoulder muscles, and in the cases seen, atrophy of the shoulder muscles has been a universal accompaniment, often reaching a high degree, and would seem to be the important factor in causing pain. Soon after the injury or overuse an extremely painful condition involving the whole arm arises, and the diagnosis of neuritis is almost always made, although legitimate symptoms of neuritis are absent. There is no disturbance of sensation, no tenderness over the nerve trunks, and no swelling of the hand. The arm feels heavy and aches after use, particularly some time after use, and wearing a heavy coat or carrying a bag on the affected side gives rise to great discomfort. There is tenderness to pressure at the root of the neck, and on the affected side the arm is carried at the side very often in a sling and is exceedingly

irritable. As a result of this position the motion of abduction becomes limited from adaptive muscular shortening of the pectoralis and latissimus muscles and perhaps later by adhesions, and abduction, even passively performed becomes limited and painful. Massage, except of the gentlest grade, is irritating and as there is generally later some limitation of abduction, by attempted use the joint is continually irritated.

The condition apparently goes on indefinitely. It would hardly be fair to say that it is always associated with neurasthenia, but the patients appear to have a well-organized nervous system and to be as a rule in poor general condition. The diagnosis of neuritis is accepted by the patient as explaining everything.

The treatment that has been most successful has been to use a sling to take off weight, to give the gentlest possible massage to improve the circulation and muscular tone, along with the use of radiant heat, and to begin as soon as possible exercises to develop certain shoulder-joint muscles. The biceps and triceps, for example, can be exercised without moving the joint. The severest cases will require the use of an abduction splint, and if adhesions are present they must be stretched by passive manipulation in abduction when acute irritability begins to diminish and then active developmental muscular exercises must be begun and continued.

The attempt has been made in this paper to call attention to certain perfectly well-known anatomical and mechanical conditions which apparently dominate the behavior of the injured shoulder. We are too apt to forget the weight of the arm and the inevitable muscular drag which must result when the muscles lose their proper tone, as all muscles of an injured joint must do at an early stage. As a result of this muscular pain and irritability we have the well-known dragging pain, especially notable at the insertion of the deltoid, the chief sufferer from this weight. Neither must we overlook the exceedingly complex nature of the joint and the intimate relation of tendons and bursæ to capsule. Injury of one structure alone must be rare, for the contact of different structures is too close to prevent it in most cases.

The moral that I would point out is that we should regard the shoulder joint as a whole when we treat its injuries, and not allow ourselves to find the explanation of all symptoms in the assumption of the inflammation of one bursa, an inflammation which frequently exists, but which does not adequately in many instances explain the symptoms present. And finally, I would plead for the primary fundamental requirements of fixation in abduction from an early stage.

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THE DIAGNOSIS AND TREATMENT OF TUBERCULOUS EMPYEMA

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TUBERCULOUS empyema may be defined as a type of suppurating pleurisy in which the tuberculosis bacillus is either the sole infective organism or is one of the organisms of a mixed infection. Dry adhesive pleuritis, pleurisy with serous effusion, and suppurative or hæmorrhagic pleurisy constitute different grades of reaction to pleural infection. The extent of the pleural reaction is in proportion to the virulence of the infection and the resistance to it.

From a pathological point of view, tuberculous pleurisy may be subdivided into primary and secondary forms. To the first belong the cases of initial involvement of the pleura; to the second, cases following lesions of the lungs, chest wall, or glands. Some writers consider all cases of tuberculous pleurisy secondary to pulmonary involvement. Cases occur, however, in which there is no demonstrable focus in the lung. In such instances the lung tissue possibly furnishes only the avenue of infection.

Primary tuberculous pleurisy with or without effusion, which has its analogue in primary tuberculous peritonitis, probably occurs more frequently than is generally recognized. Hodenpyl found nodules and patches on the visceral pleura in 44 of 91 cases in which the lungs were free from tuberculosis. These nodules were proved to be tuberculous by microscopic examination in 41 cases, and in 3 without nodules foci of tuberculosis were demonstrated microscopically. Hodenpyl regards this type of involvement as the most likely to heal spontaneously. To the same group belongs probably a large proportion of the cases of primary adhesive pleuritis and pleurisy with effusion. The analogy to tuberculous peritonitis of the dry plastic and ascitic types is striking.

The question of the etiology of primary or idiopathic pleurisy with effusion is of especial importance in the consideration of tuberculous empyema. Although Cabot, Rist, and Webb expressed doubt with regard to the tuberculous nature of the primary serous effusions observed in the American Expeditionary Forces, there is much evidence to substantiate the view commonly accepted, that save for an occasional instance of effusion complicating unrecognized pneumonia, these are tuberculous in nature. This evidence is furnished by the investigation of the further history of cases of pleurisy with effusion, and by a study of the fluid. Series of patients whose course is followed for from 5 to 20 years show that from 35 per cent to 55 per cent eventually die of tuberculosis (Osler, Hedges, Sears, and others). Insurance companies find that deaths from tuberculosis among persons having had pleurisy with effusion is three times the average (Norris and Landis). Of special interest is a series of Koester, who found that of 514 patients 245 became tuberculous. About 50 per cent of the patients had active lesions before the end of 5 years, but a latent period of 10 years or more was noted in about 7 per cent of 164 cases.

The demonstration of tuberculosis bacilli in the serous exudate constitutes the most convincing evidence of its tuberculous nature. Direct examination of the sediment obtained by centrifugalizing the digested clot, the so-called inoscopy of Jousset, and animal inoculation, have yielded positive results in from 20 to 85 per cent of the cases. The widely divergent results are probably due to differences in technique, and in the animal inoculations to the varying virulence of the bacilli. By inoscopy positive results were obtained in 20.8 per cent in a series of 115 cases at the Massachusetts General Hospital (Goodall); in 65 per cent by Zebrowski; in 45.4 per cent in a series of 51 cases reported by Musgrave and in 100 per cent in 20 cases reported by Jousset. Animal inoculation yielded only 33 per cent positive results in Musgrave's series, but Daminy, using 300 cubic centimeters of exudate in divided doses of 10 cubic centimeters each, obtained positive

results in 48 of 50 cases. Spengler states that he has always been able to demonstrate tuberculosis bacilli by using 200 cubic centimeters of exudate aspirated from the lowest portion of the pleural cavity. Musgrave demonstrated the bacilli by inoscopy in 8 cases in which the guinea pig test was negative. The varying virulence of the bacilli is indicated by the fact that he obtained negative results in three animals injected with three successive tappings, but 6 months later obtained a positive result Barjome and Cade also found that only one of three or four animals gave a positive test. These experiences emphasize the uncertain significance of a single injection of a few cubic centimeters of fluid in one animal.

Musgrave regards a positive tuberculin test and a relatively large percentage of lymphocytes in the exudate as of diagnostic value.

A serous effusion may persist for months and recur after repeated tapping (Fyfe), or it may promptly subside after one or two aspirations. Patients should not be repeatedly tapped, however. If the effusion persists, it may remain serous, or, as often happens, especially after frequent tapping, it may become purulent. Very little seems to be known regarding the conditions which govern these changes. Floyd concludes from an experimental study, injection of dead and living pyogenic bacteria into the pleural cavity, that the varying reactions depend on the relative virulence of the organism, and that when there is but little chemotaxis, pleurisy with or without effusion results, but that if the chemotactic action is profound and the elaborated toxin not too destructive, empyema results. Opie, on the other hand, using graded amounts of turpentine as the pleural irritant, which produces effusion, found an increased tendency to purulent change following aspiration of the fluid. He believes that this difference may be due to an increased activity of the leucoprotease of the polynuclear leucocyte normally held in check by the anti-enzyme of the exuded serum.

In contrast to the cases of primary idiopathic pleurisy are pleurisy in the lung, chest wall, or glands. The common pneumonic pleurisy with or without effusion is an analogous condition. Lord found a serous effusion in 5.2 per cent of 1185 cases of pneumonia, and Musser reports 5 serous and 20 purulent effusions in 127 necropsies following pneumonia. In the recent epidemic of streptococcus infection, pleural effusion was the rule.

Tuberculous infection of the pleura is a common concomitant of pulmonary tuberculosis. Osler writes that the visceral pleura is always involved. The frequent resultant partial obliteration of the pleural cavity may account for the fact that a relatively large proportion of cases do not develop late effusion. In the absence of obliterating adhesions, the pleural cavity may become grossly infected by the rupture of a subpleural focus, producing a spontaneous pneumothorax. This occurs in from 4 to 10 per cent of institutional cases of tuberculosis (Gutmann, Eichorst, Cruice). The presence of apical pleurisy should be considered as a benignant process of conservation. This complication is usually announced by marked symptoms. A mixed infection usually results, which makes the prognosis grave. Spontaneous pneumothorax, however, may have an insidious onset, and not give rise to marked symptoms. Such cases are of the "latent, mute" type of pneumothorax which are most liable to develop a purulent effusion (Bouchut and Gravier). Baeumler reports two cases in which the exudate remained serous in the presence of pneumothorax.

Tearing the lung by band-like adhesions occurs as a complication of the pneumothorax treatment of pulmonary tuberculosis (Cocke, Marshak and Craighead, Webb, and others). Duboff reports 10 cases of effusion in 48 of which artificial pneumothorax had been used. Spengler states that an effusion resulted in 50 per cent of 100 such cases. He believes that the exudation is due to loosening up of pleural adhesions.

The bacteriology of undrained tuberculous empyema has been less well studied than has that of tuberculous pleurisy. Netter (59), in a series of 109 cases of purulent pleurisies, found tuberculosis in 15.2 per cent, but in 13

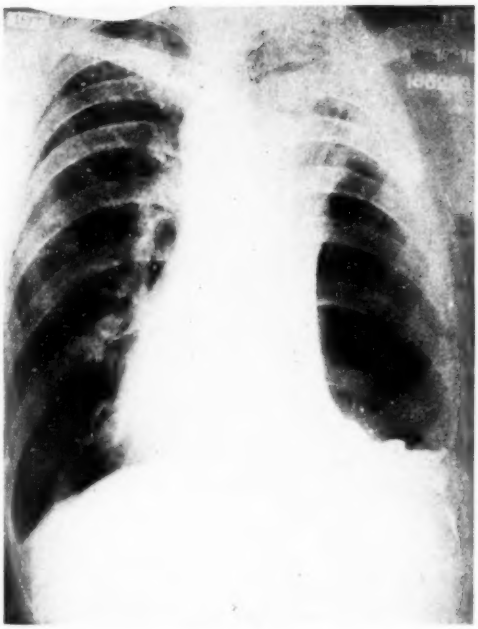

Fig. 1. Case 185290. Chronic tuberculous empyema of about 3½ years' duration with almost complete collapse of the lung, September 19, 1919.

Fig. 2. Case 185290. Chest shown in Figure 1 following a Wilms' three-stage plastic operation. Complete obliteration of the cavity, April 7, 1920.

cases diagnosed tuberculous empyema he found the bacilli in only 5 (Sokottowski). In 6 cases there was no growth. He regarded the cases which were sterile to culture as tuberculous. Ehrlich found tuberculosis in 7 of 19 cases of empyema, Fraenkel found it in 1 of 12 cases, and Renvers in 2 of 15 cases. Netter writes that one always should obtain positive results in tuberculous empyema either by guinea-pig inoculation or by direct examination. Staphylococcus in pure culture is uncommon, but when present is suggestive of tuberculosis (Netter, Sokottowski). A sterile purulent effusion is tuberculous in the majority of cases (Sokottowski).

In chronic draining empyemata bacteriological study is of little value. Beck (6) reports staphylococci in practically all cases and streptococci in 10 per cent. Gordon, in an intensive study of 25 chronic cases, concludes that the primary organism, notably streptococcus, disappears, and that there may be a succession of secondary invaders. It seems evident, however, that, although a mixed infection always occurs in these drained cases, the tuberculous infection persists. Beck (3) states that tuberculosis is rarely found in secretions even in cases in which the empyema is positively of tuberculous origin, but that the bacilli may be demonstrated in numbers in the exudate after treatment with bismuth paste, which he believes stimulates leucocytosis, the leucocytes carrying the bacilli out in the discharge. Heuer refers to a case in which bismuth paste was used after which the exudate teemed with bacilli.

DIAGNOSIS

Positive proof of the tuberculous nature of a purulent exudate is afforded by finding the bacilli in the exudate by direct examination, by animal inoculation, or by a demonstration of the characteristic microscopic picture in the excised pleura. Unfortunately the demonstration of the bacilli in the exudate is usually difficult, and the animal inoculation

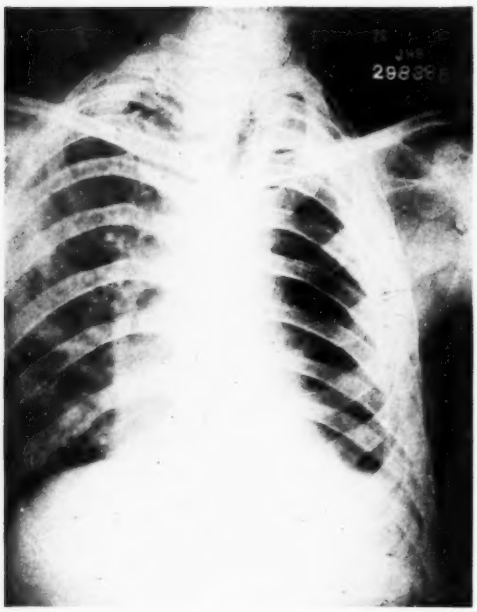

Fig. 3. Case 298385. Chronic empyema cavity of sixteen years' duration.

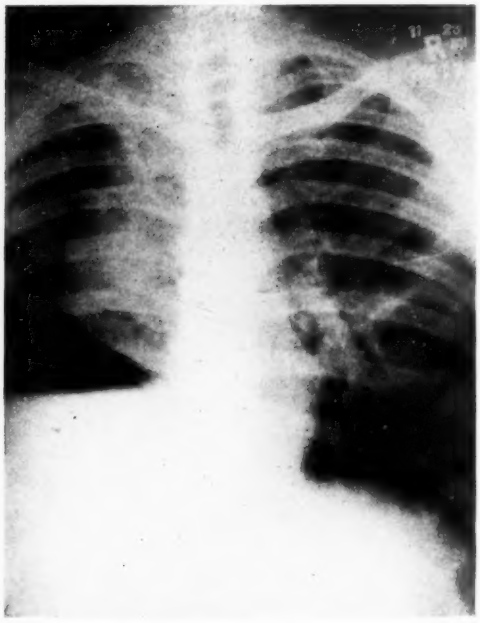

Fig. 4. Case 341738. Chronic tuberculous empyema cavity of two years' duration.

test results in many failures and requires at best 6 weeks of time. The examination of pleural tissue is a postoperative procedure. In the ordinary case, therefore, a presumptive diagnosis must be made on the clinical history of the case, the character of the exudate, and the recognition of a tuberculous process in some other organ.

History. A family history of tuberculosis is of some value. Cabot showed that in a series at the Massachusetts General Hospital of 300 patients with pleurisy, 67 per cent who later developed tuberculosis had a positive family history, while only 25 per cent of those who remained well had such a history. An insidious onset without preceding infectious disease, especially if accompanied with fever, night sweats, loss of weight and strength, loss of appetite, and progressively increasing nervousness, is always suggestive of tuberculous infection. The cases with insidious onset in apparently healthy, robust persons are among the most difficult to recognize. A history of preceding pleurisy with effusion, even though years before, affords grounds for suspicion that a later "idiopathic" empyema may be tuberculous. A history of pleurisy with serous effusion in an adult should be evaluated equally with that of an hæmoptysis (Lemon).

Character of exudate. In cases without drainage, sterile, purulent fluid, especially in the presence of fever and with a low leucocyte count, is almost certain to be tuberculous. Staphylococcus infection, ordinarily rare in undrained empyema, has been found associated with tuberculosis. A pyogenic organism, notably pneumococcus, may die, but an effusion giving a negative culture and smear may be considered tuberculous.

The presence in other organs of a tuberculous lesion, notably pulmonary phthisis and tuberculous peritonitis, lends weight to a presumptive diagnosis of the tuberculous nature of co-existing empyema. A healed or quiescent pulmonary process such as is often seen in the roentgenogram is probably, taken by itself, of relatively little significance, but an

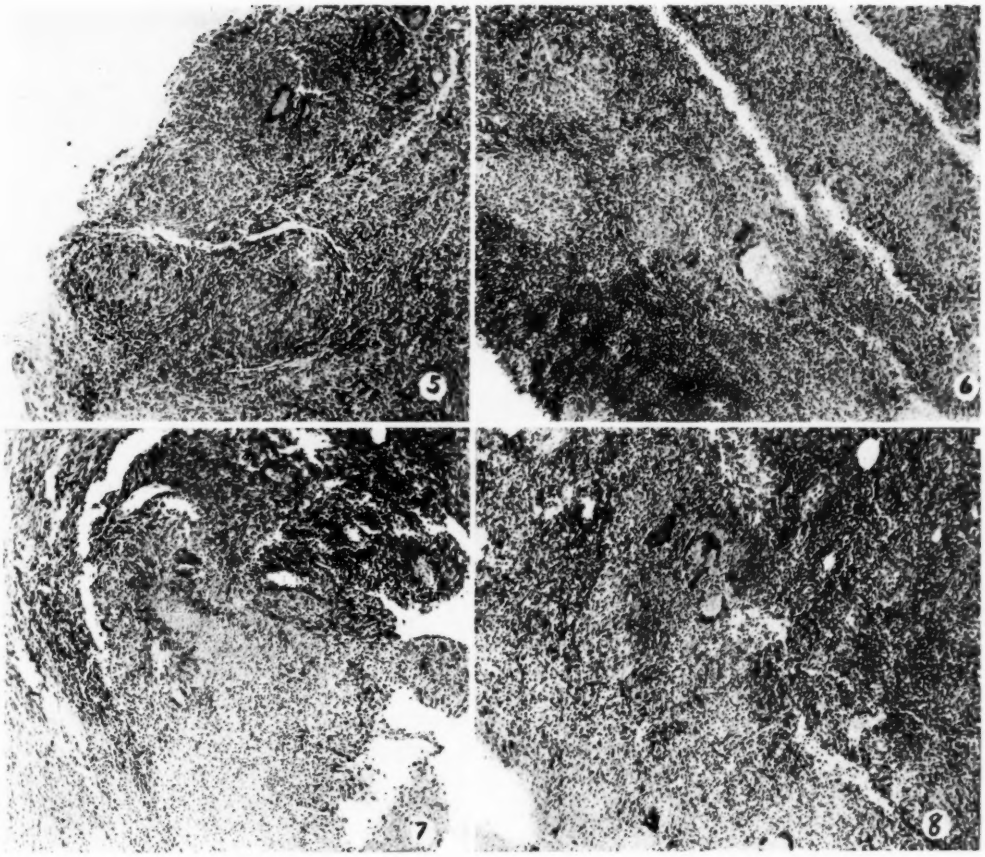

Fig. 5. Case 47717. Typical tubercles and foreign-body giant cells associated with marked lymphocytic infiltration in a tuberculous area in the parietal pleura.

Fig. 6. Case 185290. Ill defined tubercles and foreign-body giant cells associated with marked lymphocytic infiltration in a tuberculous area in the parietal pleura.

Fig. 7. Case 362614. Few foreign-body giant cells associated with marked necrosis, lymphocytic infiltration, and fibrosis in a tuberculous area in the parietal pleura.

Fig. 8. Case 289416. Ill defined tubercles and foreign-body giant cells in an area of tuberculous granulation tissue of the parietal pleura.

active process giving rise to characteristic râles, and especially positive sputum examination, leaves little room for doubt with regard to the tuberculous nature of an idiopathic purulent effusion. Effusion complicating artificial pneumothorax therapy, or following spontaneous pneumothorax in advanced cases, is probably tuberculous, even in the presence of pyogenic organisms, which in such cases contribute to a mixed infection. Fagiuoli reports serous effusion in 10 of 23 cases in which pneumothorax therapy was used.

MAYO CLINIC SERIES

The records of the Mayo Clinic since 1910 contain histories of 23 cases proved by bacteriological or pathological examination to be tuberculous empyema. These cases are included in Group 1. Fifty-one cases not so proved, in which a tuberculous lesion elsewhere, or other clinical features, make for at least a probable diagnosis of tuberculous empyema, have been classified into Groups 2, 3, and 4.

Group 1. In the 23 patients in this group the diagnosis was made or was confirmed by

examination of excised pleural tissue, in 18. Guinea-pig inoculation of the exudate was positive in one in the purulent stage and was positive in one in the serous stage; necropsy in the latter case showed pyopneumothorax, and tuberculosis of the lungs, liver, and retroperitoneal glands. Tuberculosis bacilli were found in smears of the purulent exudate in 3. Five patients had well-marked tuberculous lesions, associated with Pott's disease of the spine and multiple "cold" abscesses in one, tuberculous glands proved microscopically in one, and in one necropsy showed, besides, a large pulmonary cavitation, tuberculosis of the kidneys and multiple tuberculous ulcers of the intestines, from the perforation of one of which the patient had died. In the fourth the onset was that of a typical pleurisy with effusion, and in the fifth the sputum contained tuberculosis bacilli.

Group 2. In this group were 16 patients with clinically tuberculous empyema. Further evidence substantiated the presence of tuberculosis. In one patient (Case 51816), besides a history of pleurisy with effusion, chronic cough with sputum, and a diagnosis at operation, "cold" abscesses developed later in the chest wall. In 2 (Cases 137779 and 260196), characteristic lesions were found at necropsy, and in one besides cough, sputum, and physical signs of phthisis, hæmoptysis developed. In the remaining 12, various combinations of positive findings as to family history, past history of pleurisy, cough with sputum, physical and roentgen-ray findings, the gross appearance at operation, and the further course, leave little question of the presence of tuberculosis.

Group 3. There were 22 patients with empyema associated with pulmonary tuberculosis in this group. Roentgen ray showed the pulmonary lesion in all. In 3 there was an active process at the time of the first examination, and in 4 later examinations showed active progressive lesions. The bacilli were found in the sputum in 4 with active pulmonary foci, and in 1 without such foci. There was a positive family history in 2; in both the lesions were active. A history of pleurisy or "cold" preceding the empyema was noted in 6, and a past history of pleurisy was noted in 9, in 3 of which the immediate preceding illness was not characterized by pleurisy. The onset of the empyema was insidious in 3, and sudden in 14. The onset was preceded by pneumonia in 10. There were various combinations of cough with sputum and fever in 16, and there were râles or bronchial breathing, or both, in 6, in 2 of which there was no cough nor sputum.

Group 4. The patients in this group had empyema following idiopathic pleurisy with effusion. They gave histories of previous attacks which occurred within a year before the onset of the empyema in 5; in 3 it occurred 2, 3, and 9 years before respectively. The time was not stated in 4. Cough and sputum were present in 7 of the 13 patients. The sputum was examined for bacilli in 5, but none was found. Reports of the end-results concerning 8 of these patients have been received. Three died. One had a large pneumothorax, and one a persistent drainage and cough and sputum up to the time of death. The empyema was healed in 5.

Summarizing the diagnostic findings in the four groups, it may be said that in 23 patients the tuberculous nature of the empyema was proved. In 38 others the patient had a tuberculous infection, determined by pulmonary lesions, shown in the roentgenogram in 22, and by characteristic histories and symptoms in 16, in 7 of which the diagnosis of tuberculosis of the pleura was made at operation from gross appearance. Two of the remaining 9 patients died of tuberculosis. A presumptive diagnosis of tuberculous empyema was made in these 38 cases. A considerable proportion of the 13 cases in Group 4, in which there was a history of pleurisy with effusion, are probably cases of tuberculous empyema.

The question of the probability of empyema being tuberculous in the presence of a pulmonary lesion is one that cannot be answered categorically. Some writers are of the opinion that they are all cases of tuberculous empyema. The almost constant association of pleuritis, even with early localized pulmonary lesions, is a matter of common observation. It seems obvious that inasmuch as patients with tuberculosis of the lungs develop secondary pyogenic lesions, pneumonia, ab-

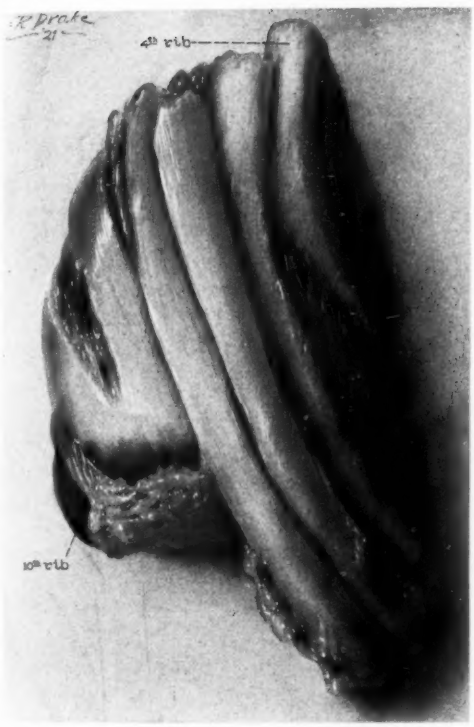

Fig. 9. Case 185290. Overriding and fusion of the ribs in tuberculous empyema of 22 years' duration.

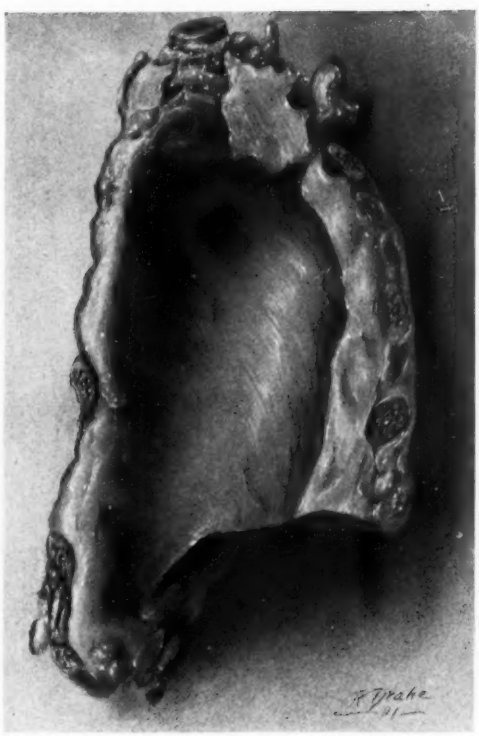

Fig. 10. Case 185290. Visceral aspect of specimen shown in Figure 9. Note thickness of parietal pleura.

scess, and so forth, they may also develop secondary pyogenic pleurisy. The difficulty of proving such cases to be tuberculous empyemata is analagous to the difficulty of establishing positive proof of incipient phthisis. Walton suggests that a distinction should be made between tuberculosis of the pleura, a secondary tuberculosis in a patient with chronic suppurating pleurisy, and suppurating pleurisy in a patient with tuberculosis. From a review of the literature it seems evident that the tuberculous nature of a large proportion of empyemata has remained unrecognized (Table I).

TABLE I.—RELATIVE INCIDENCE OF TUBERCULOUS EMPYEMATA REPORTED

Author	Cases	Diagnosis of tuberculosis	Percentage
Martin	21	3	14.2
Bergeat	21	4	19.0
Bethell	40	10	25.0
Wilensky	82	13	15.8
Moutard-Martin	84	7	8.3
Dunlop	98	3	3.0
Grieg	100	6	6.0
Netter (60)	109	12	11.0
Hirano	118	3	2.5
Voswinckel	129	14	10.0
Nathan	145	10	6.8
Holsti	166	12	7.8
Schede (68)	484	45	9.3
Hedblom	360	61	17.0

A more careful study of cases of chronic empyema in general, of cases in which there is a tuberculous focus, and of cases in which there is a history of a primary pleurisy with effusion, will undoubtedly prove a considerably larger proportion to be tuberculous.

TREATMENT

In the treatment of tuberculous effusion, account must be taken of its varied pathology and of the patient's condition. A distinction

GROUP I.— TUBERCULOUS EMPYEMA

Case	Sex and age	Pleurisy	Illness at onset	Onset sudden or insidious	Cough	*Bacillus tuberculosis* in sputum	Rales	Roentgen-ray findings	Previous operation	Diagnosis of tuberculosis	Operations	Pathological diagnosis	Remarks
47717	M 45	O	Influenza	S	+	+		Fluid	7 aspirations	O	2-18-19 Plastic, resection of three ribs, after Dakin's solution treatment. 5-2-19 Skin plastic	5-2-19 Tuberculosis of parietal pleura	2-20 Complete healing
54092	M 26	+	Pleurisy	S	+	+		Right tuberculosis; thickened pleura; left effusion	6-09 Drainage		6-10-11 Drainage (mixed tuberculous infection)		1914 Death. Empyema never healed; patient had pulmonary tuberculosis
101014	M 39	+	Pleurisy	S	+			Retraction	5 aspirations; rib resection	+	2-27-14 Partial Schede. 10-6-15 Skin plastic 6-29-17 Aspiration psoas abscess	6-17-16 Tuberculosis of parietal pleura	1-9-19 Death from influenza; no necropsy. Multiple "cold" abscesses; Pott's disease
107204	F 26	O	Pneumonia		+	+		Old tuberculosis; bronchial thickening	1914 Aspiration; tuberculous glands		8-21-17 Drainage		8-17 Death from septicæmia; no necropsy
111007	M 36	O	Abscess	S	+			Right empyema; thickened and retracted pleura	7-13 Rib resection	O	7-29-14 Drainage. 4-24-15 Multiple rib resections. 7-8-15 Minor Schede	7-2-15 Tuberculosis of parietal pleura	1917 Last report; good health slight drainage
111478	F 18	O	Pneumonia	S	+	+	+	Fluid; thickened pleura	5 aspirations	O	8-4-14 Rib resection for drainage. 4-17-15 Incision for drainage. 8-20-19 Exploration, no cavity found	4-17-15 Tuberculosis of parietal pleura	8-21 Wound still draining
116166	M 40	+	Pleurisy	S	+	+		Left empyema; thickened pleura	9-13 Rib resection	O	9-29-14 Drainage. 8-6-15 Schede operation. 12-17-15 Rib fragment removed	12-17-15 Tuberculosis of parietal pleura	6-16 Wound almost healed; good health
130190	F 15	O	O	I	+			Empyema; thickened pleura; lung retracted	10-14 Aspiration; rib resection	+	6-9-16 Rib resection for drainage	3-30-16 Tuberculosis of parietal pleura 6-7-16 Tuberculosis of parietal pleura	8-17 Wound healed; no trouble since
149126	M 40	+	Pleurisy; grippe	I	+	+	+	Fluid; left lung collapsed; tuberculosis right	1914 12 aspirations	+	1-7-16 Rib resection for drainage	1-4-16 Tuberculosis bacilli in pleural exudate	7-16 Death
163637	M 44	O	Typhoid; pneumonia	S	O	+		Right empyema; large pocket	3 rib resections	O	6-30-16 Exploration after Dakin's solution treatment. 8-9-19 Schede	8-9-19 Tuberculosis of parietal pleura	9-10-19 Death; lung abscess, bronchial fistula, tuberculous empyema, tuberculous meningitis. No necropsy
185290	M 38	+	Pleurisy	S	O	O	+	Upper left tuberculosis; fluid	3-18 Drainage	+	8-12-19 Exploration and curettage; preliminary Dakin's solution treatment. 3-16-20 Wilms first stage, after Dakin's solution treatment. 3-25-20 Wilms second stage. 5-20-20 Wilms third stage	4-2-17 Tuberculosis by guinea-pig inoculation; 8-12-19 Tuberculosis of parietal pleura	3-21 Good health; slight drainage

217107	M 53	O	Cold	I	+		+	Tuberculosis both apices; fluid	Aspiration	+	12-23-17 Rib resection for drainage	12-17 Tuberculosis of parietal pleura	12-27-17 Death. Necropsy; perforation tuberculous ulcer of ileum; multiple tuberculous foci
230390	M 21	O	Cold	S	+	+		Fluid; heart enlarged		O	9 aspirations. 6-22-18 Rib resection for drainage; septic pyopneumothorax	6-24-18 Tuberculosis by guinea pig inoculation	6-28-18 Death. Necropsy; tuberculosis both lungs, liver, retroperitoneal glands
251743	M 22	O	Chill?		O		+	Lung retracted; right pneumothorax; fluid	3-17 Aspiration; drainage	O	12-12-18 Decortication after Dakin's solution treatment. 3-4-19 Rib resection for drainage. Patient refused extensive plastic	3-3-19 Tuberculosis of parietal pleura	4-21 Wound still draining; treatment incomplete
260767	M 32	?	Lung abscess	I	+			Infiltration left lung	1913 Abscess left axilla	O	2-27-19 Exploration. 3-6-19 Negative aspiration. 3-30-19 Negative aspiration. 7-17-19 Rib resection for drainage.	7-17-19 Tuberculosis of parietal pleura	Much improvement when last seen. Developed pulmonary tuberculosis, apparently as secondary complication
262614	F 27	+	Pleurisy; childbirth	I	+			Fluid	2 aspirations; rib resection	O	3-25-19 Decortication, after Dakin's solution treatment. 3-1-21 Rib resection and skin muscle plastic (bronchial fistula)	3-25-19 Tuberculosis of parietal pleura. 3-1-21 Tuberculosis of parietal pleura	4-21 Wound practically healed
263092	F 21	+	Pleurisy; childbirth	I			+	Lung collapsed; probably fluid	2 aspirations; 12-18 drainage	O	3-27-19 Decortication, attempted. 11-19 Rib resection for drainage	12-19 Tuberculosis smear and pleura	12-19 Death from hæmorrhage
263570	M 27	+	Pleurisy	S	+	+		Probable empyema, left, tuberculosis; interlobar pleurisy right lung	6-18 drainage	O	3-18-19 Exploration after Dakin's solution treatment. 3-27-19 Rib resection and skin plastic	3-27-19 Tuberculosis of parietal pleura	5-20 Death
274687	M 54	+	Influenza	S	+			Pleural thickening; probably fluid	2-19 Drainage	O	6-28-19 Rib resection for drainage	6-28-19 Tuberculosis of parietal pleura	9-20 Slight drainage; patient working
289416	M 54	+	?	I	+	+		Left empyema; small pocket	1909, 11 aspirations, 1918 drainage	O	10-16-19 Decortication after Dakin's solution treatment. 10-19-20 Rib resection and skin muscle plastic	10-19-20 Tuberculosis of parietal pleura	4-21 Wound healing; some pain
333166	M 29	+	Pleurisy; influenza		+	O	+	Pleurisy	12-19 Rib resection. 2-20 Drainage	O	9-14-20 Aspiration, preliminary Dakin's solution treatment. 10-4-20 Rib resection and skin muscle plastic	10-4-20 Tuberculosis of parietal pleura	10-10-20 Appendectomy; gangrenous appendix 4-21 Patient in sanitarium; drainage; high temperature, and so forth
333476	M 29	+	Influenza; pleurisy	I	O	+		Density; abscess	8-19 Rib resection	O	10-14-20 Decortication after Dakin's solution treatment. 12-9-20 Rib resection and skin plastic	12-9-20 Tuberculosis of parietal pleura	3-21 Health good; wound healing slowly
340048	M 30	O	Influenza	I	+	+		Empyema; lung collapsed; fluid in right base	Aspiration; drainage; wound reopened	O	12-21-20 Rib resection and skin muscle plastic	12-21-20 Tuberculosis of parietal pleura	4-21 Narrow sinus; prognosis good

GROUP II.—CLINICALLY TUBERCULOUS EMPYEMA

Case	Sex and age	Pleurisy	Illness at onset	Onset sudden or insidious	Cough	*Bacillus tuberculosis* in sputum	Râles	Roentgen-ray findings	Previous operations	Operations	Pathological diagnosis	Remarks
22359	M 33	O	"Cold"	I	+	+	+	Right empyema; tuberculosis of left lung	1909 Aspiration	3-23-15 Rib resection for drainage		Patient left Clinic much improved. Death reported
51816	M 39	+	Pleurisy	S	+	+		Old pleurisy		4-19-11 Rib resection for drainage. 12-12-11 Redrainage		Results unknown
121241	M 4	O	Pneumonia	S	+	+	+	Possibly fluid; tuberculosis both sides; thickened pleura		12-28-14 Rib resection for drainage		Death one week after discharge from Clinic
137779	M 42	O	"Cold"	I	+	+		Fluid; congestion	6-15 Negative aspiration	8-7-15 Drainage empyema necessitatis. 8-16-15 Drainage. 8-20-15 Redrainage	8-21-15 Chronic inflammation of pleuræ	8-28-15 Death. Necropsy; empyema; lung abscesses; perforation between bronchus and pleura
150774	F 22	O	Pneumonia	I			+	Thickened pleura	3 drainage operations	1-28-16 Drainage	1-28-16 Chronic inflammation of pleuræ	Intermittent drainage; patient's general health fair
155193	M 43	O		I				Calcified pleura		3-31-16 Drainage. 10-20-16 Rib resection; redrainage; calcification of pleura	3-31-16 Inflammation of pleuræ	1917 Last report; draining
165322	F 57	+		S	+	+		Probable fluid	Aspiration	7-16 Three aspirations. 7-31-16 Rib resection; drainage. 5-4-18 Exploration and redrainage		Last operation incomplete at patient's request. 3-21 Wound decreasing in size but not healed
167061	M 55	O	"Cold"	I	+	+		Fluid	6-16 Aspiration	7-28-16 Rib resection for drainage	7-26-16 Exudate negative	Death 2 weeks after discharge from the Clinic
260196	M 25	+	Pneumonia	I				Retracted ribs; thickened pleura	5 drainage operations	2-18-19 Rib resection; skin plastic. 3-18-19 Skin plastic	3-18-19 Chronic inflammation of pleuræ	Wound completely healed; patient developed tuberculous meningitis. Death 4-20
264318	M 42	+	Pleurisy	I	O			Schede operation left; tuberculosis both apices	3 drainage operations	4-3-19 Exploration and drainage		8-8-19 Death
288515	F 31	+		I				Fluid, ribs resected	2 drainage operations	9-16-19 Aspirations, Dakin's solution treatment. 9-18-19 Exploration; drainage	9-18-19 Chronic inflammation of pleuræ	3-20 Side healed; good health since
292083	F 27	+		I	+	+	+	Old empyema; pneumothorax left lung thickened pleura; tuberculosis right	1917 Aspiration	10-14-19 Aspiration	10-14-19 Pleural exudate negative	Patient sent to sanitarium
298385	M 38	+	Pneumonia	S				Congestion left lung; pneumothorax right	Several aspirations. 1903 drainage	12-11-19 Exploration; Dakin's solution treatment		Patient too sick for radical operation; result not known
299285	M 26	+	Pleurisy	S	O	O		Pneumothorax	Several aspirations; 2 drainage operations	1-15-20 Rib resection and skin plastic. 11-9-20 Rib resection and skin plastic	1-15-20 Chronic inflammation of pleuræ	7-21 Good health; wound healing rapidly
300040	M 66			I	+	+		Fluid left; old empyema right; calcified tuberculous pleurisy left		12-24-19 Aspiration	12-19-19 Pleural exudate negative	3-21 Reaccumulation of fluid; further operation not advisable
302859	M 58	+	Pneumonia	S	+	+	+	Old empyema, right; large pocket	1912 Aspiration; drainage	1-27-20 Rib resection; drainage. 3-9-20 Rib resection and skin plastic (bronchial fistula)	1-27-20 Chronic inflammation of pleuræ	1-21 Wound healed; patient working and in good health

must first be made between effusion in a closed pleural cavity and one in an open cavity. The exudate in a closed cavity may be sterile or secondarily infected; that in an open cavity is always secondarily infected.

Pleural effusion in a closed cavity. A sterile effusion in a closed cavity may be serous, hæmorrhagic, or purulent. The presence of enough exudate to be clearly recognized clinically is usually considered as an indication for aspirating as much of the fluid as can be obtained. Certainly enough fluid to produce symptoms of mechanical embarrassment to respiration and circulation is generally considered a clear indication for the aspiration of large amounts of fluid. Evidence has been brought forward, however, to show that a sterile exudate exerts a healing effect in a tuberculous process in the lung. Koeniger reports 78 cases in which marked improvement occurred in all but 3 per cent, and the improvement seemed lasting in more than half. Similar observations have been reported by Mongour, Schroeder, Kaufmann, Muralt, and others. Spengler and Sauerbruch point out that this does not seem to be due to the mechanical compression of the lung because the improvement observed is not in proportion to the amount of exudate and consequent compression of the lung. They believe the result to be due to a biological process of great importance. Koeniger attributes the improvement to a chemic process inducing auto-immunization.

On a somewhat similar basis, Gilbert proposed injecting some of the aspirated fluid subcutaneously. Others have since advocated the treatment. Fishberg reports 14 cases, in 11 of which treatment was beneficial, and Lyter reports 23 cases with favorable results in 8. When it is considered, however, that the exudate probably contains living tuberculosis bacilli, the rationale of such treatment seems questionable.

From the foregoing it appears very doubtful if it is ever advisable to remove large amounts of fluid at one time. Aside from a possible biological influence exerted by the fluid, its aspiration may exert an unfavorable influence on a co-existing incipient or active pulmonary lesion. Spengler states that miliary tuberculosis has been known to follow. Clinical experience has also shown that, whereas aspirating a large amount of fluid seems to stimulate further exudation, the aspiration of a relatively small amount results in an augmented rate of spontaneous absorption.

In order to prevent re-expansion of a tuberculous lung, whether by aspiration or rapid spontaneous absorption of the fluid, nitrogen or filtered air may be injected to replace all or a part of the volume of the fluid removed. Such treatment is especially indicated in case effusion follows artificial pneumothorax therapy.

Patients with sterile purulent exudate are of the type most liable to become the victims of injudicious surgery. This condition represents an exception to the rule *ubi pus ibi evacue* for the simple reason that there is no pus in the sense of the word used in this hackneyed phrase. A sterile, purulent exudate presents essentially the same condition as a serous exudate, and should be treated on the same principles. In many cases in which there are considerable amounts of purulent exudate in the pleural cavity, remarkably little evidence of its presence is shown. Baeumler reports the case of a young girl who remained well nourished, free from fever, and who worked regularly for 3 years, although from 1000 to 1700 cubic centimeters of pus were aspirated at intervals. Such patients should not be aspirated indefinitely, however, but an extrapleural plastic operation should be performed. Aside from the danger of a mixed infection, either introduced during repeated aspiration or a concurrent infection elsewhere metastasizing to the pleura, there is probably in most cases a marked and progressive thickening of the diseased pleura, making the collapse of the cavity by an extrapleural plastic operation more difficult.

A mixed tuberculous and pyogenic infection in a closed cavity, especially with marked sepsis, requires prompt drainage, either by the open or by the closed method, with antiseptic solution drainage. Sterilization by the antiseptic irrigation of the closed cavity has the distinct advantage that the cavity may be considerably reduced in size, and a later

GROUP III.—EMPYEMA ASSOCIATED WITH PULMONARY TUBERCULOSIS

Case	Sex and age	Pleurisy	Illness at onset	Onset sudden or insidious	Cough	*Bacillus tuberculosis* in sputum	Râles	Roentgen-ray findings	Previous operations	Operations	Pathological diagnosis	Remarks
40116	M 21	O	Pneumonia	S	+	+		Tuberculosis?		8-2-10 Drainage		Empyema healed in 1910. Severe chronic nephritis
47069	M 56	+			+			Tuberculosis opposite side	Aspiration	6-30-11 Rib resection; drainage		Wound had completely healed; patient's general condition much improved at last report. Death, cause unknown
70299	F 20	+	Pleurisy	S		+	+	Probable fluid; thickened pleura; tuberculosis left lung	Aspiration negative	7-29-12 Rib resection for drainage	7-10-12 Pleural exudate negative	Sinus healed once; reopened during pregnancy 1916. Last report very poor condition
73093	M 19	O	"Cold"	S	+		+	Compression and empyema with cavity, left lung; tuberculosis both upper lobes	Aspiration	9-18-12 Rib resection for drainage	9-3-12 Mixed infection in pleural exudate	4-16 Death
73419	M 18	O	Pneumonia	S				Fluid left lung; thickened pleura tuberculosis both upper lobes	9-10 Drainage	9-16-12 Rib resection; drainage. 11-27-12 Decortication		Wound completely healed; general condition good
85430	M 13	+	Pleurisy	S	+	+		Empyema right; tuberculosis right upper lobe		7-14-13 Rib resection for drainage 1-19-14 Redrainage		Health excellent; wound healed soon after second operation
87487	M 42	O	Pneumonia	I	+	+	+	Abscess left lung; tuberculosis left lung		7-15-13 Rib resection for drainage		Following operation the patient developed paraplegia of legs. Death within a year
87538	M 46	O	"Cold"	I	+	+	+	Old tuberculosis and marked density left lung		7-18-13 Rib resection for drainage (calcareous pleura)		Operation elsewhere for abscess formation. Death 1914
120182	M 19	O	Scarlet fever	S	+	+		Thickened and retracted pleura; tuberculosis left lung; old empyema right	1-14 Drainage	12-11-14 Drainage. 3-16-15 Rib resection and skin muscle plastic		Condition fair; permanent healing not secured
123274	M 18	O	Typhoid	I	+			Tuberculosis ? left lung; old empyema right	10-14 Drainage; 11-14 Aspiration	2-3-15 Rib resection and skin muscle plastic		Complete cure
158179	M 63	O	Trauma		+	+		Calcified tuberculous pleura left; fibrosis	6-16 Drainage	5-2-16 Drainage	6-6-16 Guinea pig inoculation negative	Healing not secured; condition fair
165708	M 57		Pneumonia	S	+	+	+	Old empyema with collapsed lung left healed tuberculosis right lung	1904 Drainage	7-17-16 Drainage	7-17-16 Chronic inflammation of pleuræ	1920 Death
198262	M 53	+	"Cold"	I	+			Empyema with retracted lung, left; tuberculosis? right lung	6-15 Drainage	6-25-17 Rib resection; drainage		Results unknown
210210	M 28	O	Gangrenous appendix and subphrenic abscess				+	Fluid, retracted lung and pneumothorax right; tuberculosis right lung	4-15 Gangrenous appendix	10-11-17 Rib resection; drainage. 11-9-20 Exploration. 12-16-20 Rib resection and skin plastic	10-11-17 Chronic inflammation of pleuræ	2-26-20 Death. Immediate cause cardiac failure

276632	M 33	O	Influenza	S	—		Effusion and thickened pleura left; healed tuberculosis right	10-18 Aspiration. 11-18 Drainage	7-1-19 Rib resection and skin muscle plastic	7-1-19 Chronic inflammation of pleuræ	Complete cure
277537	M 34	O	Influenza	S	+	+	Thickened pleura and fluid; tuberculosis left lung		7-1-19 Rib resection; drainage. 9-29-19 Exploration and Dakin's solution treatment.	7-1-19 Chronic inflammation of pleuræ	Complete cure
284600	M 23	+	Pneumonia	S	+	+	Thickened pleura; healed tuberculosis both lungs	6-18 Drainage; 11-18 Drainage	8-16-19 Exploration and Dakin's solution treatment. 11-4-19 Drainage	11-4-19 Chronic inflammation of pleuræ	Cavity still draining; plastic operation probably indicated
290735	M 23	O	Pneumonia	S	+	+	Thickened pleura	3-17 Drainage	10-2-19 Exploration and Dakin's solution treatment. 10-14-19 Drainage		Wound completely healed
301668	M 27	+	Pneumonia		+	+	Tuberculosis of left lung; effusion	3-18 Drainage	2-24-20 Exploration and Dakin's solution treatment. 3-4-20 Rib resection and drainage		Steady improvement
324812	M 18	+	Influenza; pneumonia	S	+	+	Fluid right; tuberculosis both lungs	3-20 Aspiration	7-24-20 Exploration and Dakin's solution treatment. 11-10-20 Exploration; drainage		Patient convalescing
341738	M 18	+	Influenza; pneumonia	S	+	+	Lung collapsed left tuberculosis with cavity right lung	3 aspirations	11-27-20 Aspirations	11-23-20 Pleural exudate negative	Patient to return for probable plastic
344041	M 27	+	Pneumonia; pleurisy	S	+	+	Thickened pleura; tuberculosis with cavity, left lung; collapsed right lung	Aspiration and 3 drainage operations	12-24-20 Exploration		Improved; patient to return for a decortication

extrapleural plastic operation may be performed if a cavity persists. The use of an irritating, and especially of a corroding, fluid, such as Dakin's solution, is, however, contra-indicated in any case of well-marked pulmonary lesion, because of the tendency to bronchial fistula and hæmorrhage from the action of the fluid on the exposed diseased area of the parenchyma of the lung.

In mild, secondary infections such as pneumococcus, it may be possible to treat the case as one of sterile effusion. Spengler recommends irrigation of the pleural cavity with salt solution, 0.5 per cent lysol solution, or a weak solution of iodine and potassium iodide. Jacobaeus recommends repeated aspiration in cases of open pleural cavities, with a view to promoting healing of the drainage opening.

Tuberculous exudate in an open pleural cavity. The opening into the pleural cavity in such cases may be through the chest wall, due to a drainage operation, or to spontaneous perforation of an empyema necessitatis, or into a bronchus due to a ruptured tuberculous cavitation producing spontaneous pneumothorax. These all result in mixed infection.

Cavities following drainage operations vary from those in which there is only a residual tubular or sinus tract to those in which the entire pleural cavity is involved. With cavities of long duration the pleura is usually thickened. Antiseptic solution irrigation in such cases is not only safe, but usually is followed by marked improvement in the patient's general condition. There may be very little thickening of the pleura, however, as in several cases in this series. In one of these, symptoms developed suggesting small bronchial fistulæ and a lighting up of a tuberculous lesion.

The hypochlorite solution seems to have little or no influence on the tuberculosis bacillus in these cases. Scholl observed a case at the Rockefeller War Demonstration hospital in 1917 in which an empyema cavity of about 500 cubic centimeters capacity was treated with 100 cubic centimeters Dakin's solution every 2 hours for 10 days. Cultures for tuberculosis at the end of that time were positive, showing that the solution did not kill the bacilli.

GROUP IV.—EMPYEMA FOLLOWING IDIOPATHIC PLEURISY WITH EFFUSION

Case	Sex and age	Pleurisy	Illness at onset	Onset sudden or insidious	Cough	*Bacillus tuberculosis* in sputum	Râles	Roentgen-ray findings	Previous operations	Operations	Pathological diagnosis	Remarks
37110	M 41	+	Pleurisy	I	+	+			5 aspirations	5-20-10 Drainage		Death
39927	F 25	+	Pleurisy	S			+		3 aspirations	7-7-10 Drainage		Result unknown
40960	M 32	+	Pleurisy	S	+	+				8-3-10 Rib resection; drainage	8-3-10 Pleural exudate not tuberculous	Result unknown
42662	M 4	+	Pleurisy and pneumonia	S					Drainage	9-3-10 Rib resection; drainage		Result unknown
61803	M 29	+	Pleurisy	S	O			Fluid right	Drainage	12-7-11 Drainage. 1-17-13 Redrainage		1913 Wound healed; patient in good health
61968	M 43	+	Pleurisy and pneumonia	S	+	+			2 aspirations	12-9-11 Drainage; 1-3-12 Redrainage. 9-21-12 Redrainage		Cure
117738	M 53	+	Pleurisy	I	+	+		Thickened and retracted pleura; drainage in superficial pocket; old empyema left	4 aspirations; 3 drainages	12-30-14 Schede; partial decortication		1915 Death; probably from pneumonia; patient had been doing very well
141627	M 24	+	Pleurisy	I	O	O		Old empyema right	9-11 Drainage	6-2-16 Rib resection and skin muscle plastic. 6-27-16 Drainage. 8-30-17 Second skin muscle plastic	6-2-16 Chronic inflammation of pleuræ	1919 General health excellent; complete cure
150376	M 31	+	Pleurisy	I	+	O		Left lung collapsed	10 aspirations; 2 drainages	9-29-16 Drainage. 8-31-18 Exploration and drainage		9-26-18 Death
174822	M 19	+	Pleurisy	I	+	+	+	Fluid right lung	10-16 Aspiration	10-11-16 Rib resection for drainage. 11-2-16 Redrainage. 11-29-16 Redrainage. 12-11-16 Rib resection for redrainage		Complete cure; general health excellent
217221	M 31	+	Pleurisy	S	O		+	Pleura thickening; pocket base right lung	Aspiration; 2 drainage operations	2-16-18 Rib resection; drainage		Result unknown
286109	M 31	+	Pleurisy	S				Retraction, right lung; small pneumothorax	3 drainage operations	1-13-20 Skin plastic and Ransohoff. 5-21-20 Skin plastic (bronchial fistula). 5-27-20 Small skin plastic	1-13-20 Chronic inflammation of pleuræ	Complete cure; general health very good
342884	F 20	+	Pleurisy; "cold"	I	+	O		Old empyema; lung collapsed, right	6-20 Thoracotomy	12-20-20 Rib resection for drainage		Patient convalescent at last report

Small cavities and sinuses seem to constitute favorable cases for the use of bismuth paste. Beck (5) reports a cure in about 80 per cent of 150 cases of chronic empyema, but he does not state what proportion of these cases was tuberculous. Heuer reports one case in which complete sterilization of a cavity resulted from the use of the paste, so that it was closed as a sterile pneumothorax, but in the case of another cavity the treatment failed.

Cases of impending empyema necessitatis require preliminary open drainage, as a sinus forms if an attempt is made to use the closed method. These cases, often of long standing, as a rule require later plastic operation.

Tuberculous empyema with large bronchial fistula due to rupture of a cavitation into the pleura may result in a virulent secondary infection and require prompt drainage, usually by wide incision, as irrigation with antiseptics is impossible. The immediate mortality in these cases is high. Often patients who survive require later plastic operation. Forlanini had 8 patients; all died. Sauerbruch reports 73 cases, 57 following pneumothorax therapy, 16 spontaneous. Fifty-three patients died, most of them soon after drainage operation.

TYPES OF OPERATIONS FOR CHRONIC TUBERCULOUS EMPYEMATA

Drainage operation. It cannot be overemphasized that the open drainage operation is contra-indicated in cases of sterile tuberculous empyema. It will do no good, and is sure to do harm, by introducing a secondary infection. Withdrawal of a part of the fluid by aspiration is indicated in such cases only if the fluid gives rise to mechanical embarrassment. In 41 patients in this series, drainage had been established elsewhere, and the cavities were, therefore, secondarily infected. Of the 35 patients who had not had drainage 5 belonged to Group 1, in which an absolute diagnosis of tuberculous empyema was made. One of the patients (Case 101014) developed mixed infection following sudden pneumothorax after having been aspirated several times for serous effusion which contained the bacilli. He died shortly after rib resection. One patient (Case 107204) died of septicæmia 6 days after rib resection. One patient (Case 217107) presented himself with symptoms of an overwhelming infection. He died 3 days after rib resection for drainage. Necropsy showed extensive tuberculous lesions and the immediate cause of death to be a perforated tuberculous ulcer of the ileum. In the smear made from one patient (Case 149126), the bacilli were found. A rib was resected for drainage. He died 6 months after operation. The fifth patient had a large seropurulent effusion following exploration for lung abscess. Later examination of the excised pleural tissue showed tuberculosis. The roentgen ray showed a wide-spread tuberculous lesion; the sputum was positive for acid-fast organisms. The empyema cavity healed, and the patient improved remarkably and remained quite well during a period of observation extending over several months.

In 7 of the 16 patients in Group 2 with clinical diagnoses of tuberculous empyema, drainage had been instituted elsewhere. On 6 of the remaining 9 rib resections had been performed for drainage, on 3 (Cases 22359, 51816 and 137779) on account of pyopneumothorax with bronchial fistulæ with associated symptoms of mixed infection. One of these patients (Case 137779) also had an impending perforation of empyema necessitatis. Two other patients had large amounts of sputum with marked symptoms of sepsis suggesting possible perforation into a bronchus. One of these two also had an impending empyema necessitatis. A sixth patient had three aspirations followed by prompt reaccumulation of pus. She was considered in too poor condition for a radical plastic operation. A simple drainage operation was performed at the patient's request, and with a view to later plastic operation. Two patients were treated by aspiration only. In one (Case 292083) the pus was sterile and the cavity small. The patient was sent back to the tuberculosis sanitarium from which she came; she died a few months later. The other (Case 300040) was aspirated and the pus was found to be sterile. He did not wish a plastic operation until after trying repeated

aspiration. He was, therefore, recommended to a tuberculosis sanitarium.

Ten of the 22 patients with pulmonary tuberculosis and an associated empyema had had previous drainage operations elsewhere. Of the remaining 12, all except 2 had rib resection as the primary operation. Pulmonary tuberculosis was present in all of these, but the general characteristics of the empyema were of the ordinary type. In 3, repeated aspiration of pus was done, and the culture showed a mixed infection. Cough with a large amount of sputum was present in 2, indicating a bronchial fistula. The other patients appeared to have ordinary empyema. In 1 of these no pus was found, but an empty cavity lined with calcareous deposit.

In Group 4, patients in whom empyema was preceded by idiopathic pleurisy, drainage operation had been performed on 8. Rib resection was performed on the other 5.

The closed method in cases of draining cavities secondarily infected is of great advantage if antiseptic solutions can be used. The Dakin's solution treatment was used for 10 patients in the first group before the diagnosis had been established. A small bronchial fistula developed in one case during the treatment, but it was not of sufficient size to make it necessary to interrupt the treatment. In one case after a few irrigations it became impossible to use the fluid on account of coughing during which the patient tasted the fluid. He developed fever and increased sputum following the treatment, and lost weight. The treatment was therefore interrupted. This case is an example of a type in which there is only partial incapacity from the presence of the tuberculous empyema, and in which it is questionable if an extensive radical operation should ever be urged. The patient declined to have a Wilms operation at the time. The antiseptic solution was relatively harmless in this case, and of great advantage in all of the other cases, since the symptoms referable to septic absorption were distinctly ameliorated.

Decortication of the lung by the Delorme-Fowler method. It seems questionable whether this operation is ever indicated in the presence of an extensive or active phthisis. In such cases fibrosis limiting the expansibility of the lung and the danger of lighting up a latent focus must always be considered. In other cases, without a demonstrable pulmonary lesion, it is impossible to separate the thickened membrane from the lung. Delorme writes that tuberculous empyema is not a contra-indication to the operation. The most favorable report found in the literature is by Violet, who reported 17 cases in which the operation succeeded in 10 and failed in 7. Tuffier states that cases in which it is difficult or impossible to liberate the lung are as a rule tuberculous.

In the present series of 74 cases decortication was attempted in 6, in all before the tuberculous nature of the empyema had been recognized. These cases have been reported elsewhere (33). In 5 the cavity seemed materially reduced at the later operation, but it is questionable whether sufficiently so to warrant the operation. In all these cases a later plastic operation was required. In one of these (Group 1, Case 263092) in which there was no demonstrable lesion in the lung the pleura was only very little thickened, but the surface of the lung was very irregular and corrugated, making decortication impossible, although the lung was freed up en masse. In one case (Group 1, Case 289416), the surface was smooth, but the pleura was thickened over the upper portion of the lung only, thinning down to normal proportions toward the base. In the other cases there was nothing about the appearance of the pleura to suggest the tuberculous condition shown by microscopic examination. In one case (Group 3, Case 73419) the cavity was completely obliterated.

Plastic operations. The Estlander extrapleural rib resection, complete resection of the whole thickness of the chest wall with the use of a skin flap (Beck, 4) a skin muscle flap following a similar resection (Robinson), extensive radical resection (Schede, 67), and the extrapleural two-stage or three-stage rib resection of Wilms have all been used with success in the treatment of tuberculous empyema. Beck's operation, which is similar in principle to the Schede operation, lends itself well to the treatment of relatively small

residual cavities following rib resection for drainage. For large infected cavities the Schede operation best meets the anatomic indications, but the mortality of the one-stage operation has been as high as from 70 to 80 per cent (Spengler and Sauerbruch, Wilms).

In cases with cavities of large size, often with an associated pulmonary lesion and usually with marked debility, a several-stage extrapleural rib resection not only gives a low mortality, but offers good prospect of cure. This operation is an outgrowth of an attempt to modify the Estlander operation. Jaboulay and Lemaire, instead of performing an Estlander resection of the ribs over the whole extent of the cavity, simply cut the ribs on the sternal border; Boiffin sectioned them at the vertebral border of the cavity. Tietze later combined the two methods and Wilms modified it by resecting segments several centimeters long, chiefly posteriorly but also anteriorly, if necessary, and dividing the operation into two or three stages. Freidrick proposed to call the procedure the Boiffin-Wilms operation. Wilms calls it the Pfeiler resection, and first used the method for collapsing the chest wall in cases of uncomplicated pulmonary tuberculosis. Kolb and later, Wilms, and others, applied the method to tuberculous empyema.

Wilms recommends resecting 10 or 15 centimeters of the sixth to the eleventh ribs posteriorly at the first operation, and 8 to 10 centimeters of the fifth to the second or first ribs, with suturing of the wound at a second operation. This permits the entire chest wall to sink in, the elasticity of the sternal ends of the ribs allowing considerable mobility. Only if further collapse is necessary are the sternal ends of the ribs sectioned. If a cavity still persists a flap can be turned back and the rib segments and the portion of the pleura overlying it can be excised. The operation can be performed under local anæsthesia; it results in but slight trauma to the tissues; the posterior incision is a safe approach to the second and to the first ribs. The operation in stages and the freedom from infection in the wounds make it relatively safe for very poor surgical risks. The advantages of the operation are almost equally great in cases in which there is mixed or secondary infection but in these there is a characteristic tendency to a persistent sinus. Wilms reports 12 cases without mortality, and other successful cases following this operation are reported by Linderstroem.

In the series of 74 cases plastic operations were performed in 12 cases in Group 1, in 3 cases in Group 2, in 4 cases in Group 3, and in 3 cases in Group 4. In Group 1, Beck's operation was performed as a preliminary operation in 3, and as a secondary operation in 9. An operation of the Schede type was performed in 5, in 1 for a draining empyema of 22 years' duration, and a Wilms operation in three stages was performed in 1. That a Schede operation is the only operation that will obliterate the cavity in some instances was obvious in the case of the empyema of 2 years' standing. The ribs were overriding and so much thickened that it was impossible to separate them for resection. The pleura, moreover, was fully 2.5 centimeters thick and very rigid. In such a case very little would probably be gained by any procedure that would not include eventually a complete resection of the enormously thickened, chronically diseased chest wall.

Resection of the scapula is sometimes desirable in plastic operations. Hellstroem believes that it should be performed in all cases.

RESULTS OF TREATMENT

The type and sequence of the operative treatment at the Mayo Clinic is indicated in Tables II and III. In these tables insertion of a tube for aspiration and Dakin's solution irrigation is listed as aspiration. Drainage operations were, for the most part, rib resections. It will be noted that the decortication was performed with one exception as a primary operation. In these cases the diagnosis of the tuberculous nature of the empyema was made from the excised pleura. Plastic resections were, as a rule, secondary procedures. The results grouped according to the operations are shown in Table IV.

The patients who had several operations are grouped under the heading of the last operation or under the operation which is judged to have contributed most to the result

TABLE II.—TYPES OF OPERATION (MAYO CLINIC SERIES)

	Aspiration	Exploration	Drainage	Decortication	Skin plastic	Skin muscle plastic	Schede operation	Wilms operation	Total
Group 1	13	5	16	5	5	4	4	3	55
Group 2	6	4	13		5				28
Group 3	1	8	18	1	1	3			32
Group 4		1	17		3	2	1		24
Total	20	18	64	6	14	9	5	3	139

TABLE III.—SEQUENCE OF OPERATIVE PROCEDURE (MAYO CLINIC SERIES)

Type of operation	First operation	Second operation	Third operation	Fourth operation	Total
Aspiration	17	1	2		20
Exploration	11	5	2		18
Drainage	41	17	4	2	64
Decortication	5	1			6
Skin plastic	4	8	2		14
Skin muscle plastic	4	4	1		9
Schede	2	2	1		5
Wilms		1	1	1	3
Total	84	39	13	3	139

obtained. It will be noted that the largest proportion of cures followed plastic operations. In the group in which a drainage operation only was performed, the high mortality is due to the relatively poor condition of these patients.

The results are grouped according to the pathological subdivisions in Table V. It will be noted from this table that of 67 patients in whom the end-results are known, about 58.2 per cent were cured, or much improved, 4.5 per cent were not improved, and 37.3 per cent died. The postoperative mortality, deaths within 2 months of operation, was 14.9 per cent.

Of the patients in Group 1, definitely proved to be tuberculous, 61 per cent were cured, or greatly improved; 39 per cent died. The postoperative mortality was 21.7 per cent. In Group 2, patients with clinically tuberculous empyema, the results are known concerning 14; 50 per cent were cured or much improved and 50 per cent died. The operative mortality was 21.4 per cent. In Group 3, patients with empyema associated with pulmonary tuberculosis, 57.1 per cent were cured or much improved, 14.3 per cent not improved, and 28.6 per cent died. The postoperative mortality was 4.7 per cent. In Group 4, patients with empyema following pleurisy with effusion, 66.6 per cent were cured or improved; 33.3 per cent died. The postoperative mortality was 11 per cent.

SUMMARY

1. Primary or idiopathic pleurisy with effusion, in a large proportion of cases, is probably tuberculous in nature.

2. A past history of pleurisy with effusion is common in cases of tuberculous empyema. In many cases the effusion is serous at the onset.

3. Tuberculous pleurisy may be primary, or it may be secondary to a pulmonary, peritoneal, or other tuberculous lesion.

4. The onset of a tuberculous effusion may be insidious or it may be sudden and associated with an acute and severe constitutional reaction. A mixed pleural infection due to the perforation of a tuberculous cavitation often runs an acute and rapidly fatal course.

5. Diagnosis of tuberculous empyema is made by demonstration of the bacilli in the

TABLE IV.—RESULTS BY OPERATION

Operation	Cure	Good health, sinus	Improvement	No improvement	Operative death	Death later	Total deaths	Unknown	Total
Aspiration			1	1		1	1		3
Exploration					1	1	2	1	3
Drainage	9	5	8	2	7	9	16	6	46
Decortication	1								1
Skin plastic	3	2			1	3	4		9
Skin muscle plastic	3	2	3						8
Schede		1			1	1	2		3
Wilms		1							1
Total	16	11	12	3	10	15	25	7	74

TABLE V.—RESULTS BY GROUPS

	Cure	Good health, sinus	Improvement	No improvement	Operative death	Death later	Total deaths	Unknown	Total
Group 1	2	7	5		5	4	9		23
Group 2	2	3	2		3	4	7	2	16
Group 3	7	1	4	3	1	5	6	1	22
Group 4	5		1		1	2	3	4	13
Total	16	11	12	3	10	15	25	7	74

exudate, by animal inoculation, or by examination of the sectioned pleura.

6. A sterile effusion is probably tuberculous. An infected effusion may be tuberculous.

7. Empyema following primary idiopathic pleurisy with effusion, or empyema of insidious onset, especially in the presence of a pulmonary or other tuberculous condition, is probably tuberculous.

8. Empyema may be tuberculous in spite of persistently negative findings over a long period of time.

9. In a closed pleural cavity a sterile effusion, whether serous or purulent, should not be treated by open drainage, except in the presence of an impending perforation of the chest wall.

10. Repeated aspiration of only part of the fluid present is indicated in cases of serous effusion producing definite dyspnœa on exertion or symptoms of circulatory embarrassment.

11. The replacing of aspirated fluid by nitrogen or filtered air may be indicated in cases in which there are symptoms of active phthisis referable to the same side as the effusion.

12. A sterile purulent effusion should be treated as though it were serous if the lung expands when fluid is withdrawn. If the lung is fixed in a collapsed condition or if the effusion persistently recurs, an extrapleural plastic operation is indicated.

13. Effusion in a closed cavity showing a mixed infection should be treated by the closed method with antiseptic solution irrigation, or by open drainage; the open drainage is indicated especially in cases of severe infection associated with extensive pulmonary tuberculosis, making irrigation hazardous.

14. Tuberculous empyema with a large bronchial fistula should be drained by the open method.

15. A large tuberculous empyema with mixed infection from a previous drainage operation or from spontaneous perforation of the chest wall requires a plastic operation, preferably after treatment with Dakin's solution.

16. A plastic operation involving closure of a bronchus offers the only prospect of

cure in case of an associated large bronchial fistula.

17. Dakin's solution irrigation may be contra-indicated in the presence of an extensively diseased lung, owing to its corroding action on any superficial lesion, possibly resulting in hæmorrhage or the formation of a bronchial fistula.

18. A plastic operation is usually eventually required in the case of closed cavities when the empyema is of long standing, and of all large, open, secondarily infected cavities.

19. An extrapleural rib resection is indicated for the collapse of closed sterile cavities. The Boiffin-Wilms operation is especially suitable for the collapse of large cavities without excessive thickening of the parietal pleura or rib deformity.

20. A skin or skin muscle plastic is indicated for the obliteration of relatively small cavities. Cases of long standing associated with greatly thickened pleura require an extensive resection of the entire chest wall after the method of Schede.

21. Operation in several stages is especially indicated in the treatment of tuberculous empyema, and, if practicable, it should be preceded by antiseptic solution irrigation. Such treatment should extend the indications for operation and should lower the postoperative mortality.

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GASTRIC HÆMORRHAGE[1]

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MASSIVE hæmorrhages from the stomach occur under different conditions. It is not my purpose to refer to those following operation upon the stomach or to those due to leukæmia, ruptured aneurism, hepatic cirrhosis, and ruptured œsophageal veins, or eroded artery.

There is a group of cases in which massive hæmorrhages take place into the stomach and in which, as far as I know neither the surgeon, the pathologist, the bacteriologist nor the physiologist have as yet offered a satisfactory explanation for the occurrence. The bleeding tends to recur at short intervals until the patient dies. We have had ten or a dozen such cases in Montreal during the past 12 years. They resemble each other very closely. The bleeding comes on suddenly, without any warning and without any recognizable, predisposing, or immediate cause. The patients at the time are in their usual health and not guilty of any notable indiscretion.

Perhaps the report of one such case may serve as an illustration.

A. L., age 33, a well-nourished, active, railroad man, a civil engineer, arrived in Montreal the morning of October 19, 1912. He had a simple breakfast with a friend, and on coming out of the breakfast room remarked that he had a pain in his stomach and felt sick. His friend replied that nothing that he had eaten could hurt him, viz:—a little fruit, a cereal, a boiled egg, coffee, and toast. In a few minutes he said, I must go up to my room and lie down. He just reached his room when he vomited some undigested food and a full pint of bright red blood. The vomiting was explosive in character. A physician was called and he applied ice to the abdomen and gave him a hypodermic injection of morphine ¼ grain with atropin 1/150. He remained in bed all day taking only sips of water and a little milk and soda water. At 9.30 in the evening he vomited a good quart of bright red blood. I saw him soon afterward. He was blanched, pulse weak, temperature below normal, suffering from air hunger and distress in mind. The room had the appearance of a shamble. The bed was soaked with blood, and blood was on the floor and rugs. He was removed to the Royal Victoria Hospital. Physical examination gave no evidence of cirrhosis or aneurism. An examination of the blood excluded leukæmia. In his personal history there was no indication of his being a bleeder. There was no history of bleeders in his family.

The stomach when uncovered appeared normal in size and shape. The transverse colon was filled with a dark clot and looked like a sausage. Rovsing's endoscope did not reveal the source of the hæmorrhage. On making an incision through the anterior wall of the stomach it was found filled with dark-colored blood clot, but no fresh blood. When the clot was cleared out, the mucosa appeared normal, no abrasions or fissures could be seen. There was no bleeding or oozing, even on handling and wiping the surface of the mucous membrane. A gastro-enterostomy was performed to anticipate and obviate distention, and the abdomen closed. An intravenous injection of 36 ounces of normal saline was administered.

He passed a fairly comfortable night and in the morning appeared bright and hopeful. There had been no vomiting. At 2 p.m. his condition was quite satisfactory. Half and hour later he vomited a large quantity of bright red blood, and died in a few minutes.

The findings, at the autopsy, were absolutely negative. A feature of interest was the abundance of hæmolymph nodes through the upper abdomen and along the aorta. One or two of these showed mottling with white as if they were occupied with secondary growth, but no tumor was found anywhere in the abdomen.

The blood showed an extremely delayed coagulation time. The psoas muscles were noted as particularly friable. There was thus no definite source of hæmorrhage to be found, and as a whole the viscera were all perfectly healthy. It would seem that there had been a diffuse oozing from all parts of the gastric mucosa. Hæmophilia was excluded by the personal and family history. The appendix was 9 centimeters in length. The mucosa of the appendix was œdematous.

In my own cases and in the cases reported to me by my colleagues, operative treatment has failed. The operation has consisted in brushing over the mucosa of the stomach as thoroughly as possible with the actual cautery and gastro-enterostomy. All patients died.

The two more recent cases that have been admitted to my service have been given transfusions of whole blood, not citrated. After the transfusions the bleeding stopped and the patients were discharged from the hospital.

[1] President's Address, Clinical Congress of American College of Surgeons, Philadelphia, October 24-28, 1921.

The history of blood transfusion is very interesting. It would seem to synchronize with the history of the Western Hemisphere. Strange as it may appear, transfusion was first attempted in the human with the object of giving young blood to an old man. "The vital powers of Innocent VIII were rapidly sinking. He had been lying for some time in a lethargic state, that was so deathlike as to make his attendants believe that all was over. Every means of restoring his exhausted vitality had been tried in vain, when a Jewish doctor proposed to attempt his cure by means of a new instrument for the transfusion of blood. Hitherto the experiment had only been tried on animals; but now the blood of the decrepit Pontiff was to be transfused into the veins of a youth, who gave him his own in exchange. Thrice in fact, was the difficult experiment made. It did no good to the Pope, and three boys, costing the sum of one ducat apiece, lost their lives, through the introduction of air into their veins. The Jewish doctor then fled, and on July 25, 1492, Innocent VIII finally expired." [1]

Samuel Pepys, F.R.S., and secretary to the Admirality in the reign of Charles II and James II mentions in his diary what he calls a pretty experiment at Gresham College, of the blood of one dog let out, until he died, into the body of another on one side, while his own ran out on the other side. The first died upon the place, and the other did very well, and is likely to do well. He then goes on to say. "This did give occasion to many pretty wishes, as the blood of a Quaker to be let into an Archbishop and such like: and as Dr. Croone says, may if it takes, be of mighty use to man's health, for the amending of bad blood by borrowing from a better body."

Apparently blood in its purity was the desirable objective as indicated by the following narrative, also from Pepy's diary. A man that was a little frantic, that had been a kind of minister, Dr. Wilkins saying that he had read for him in his church, a poor debauched man, was hired by the college for 20 shillings to have some of the blood of a sheep let into his body. They proposed to let in about 12 ounces, which they computed would be what would be let in in a minutes' time by the watch. Pepys met the man afterward, when he said he found himself much better and as a new man. Pepys adds that the man is cracked a little in his head though he speaks very reasonably and very well. He had but 20 shillings for his suffering and is to have the same thing again tried upon him.

DaCosta of this city gives a very interesting résumé of the history of transfusion, mentioning the work of Lower of Oxford and Sir Christopher Wren in 1665, and Dr. Croons' experiment in 1666.

We are more familiar with blood transfusion for blood lost. The blood in some cases has been taken from animals. As a student, on two occasions I assisted one of my old teachers in transfusing blood from a sheep to men suffering from railroad injuries and great loss of blood. Unfortunately they were not successful. The predominant idea was to replace what had been lost.

Human blood, whole or defibrinated, was for many years regarded as the correct treatment of exsanguinated patients. It was afterward found that any suitable innocuous fluid gave apparently as good results when injected into the veins as did blood: that the essential was to restore a degree of arterial tension and render the heart's action effective. Normal saline solution was the fluid generally selected. It was easily prepared, the immediate results were good, there was freedom from the risk of embolism and it entailed no sacrifice of blood by another. The experiences of the war changed our views. It was shown by Crile and confirmed by others that blood transfusion restored the blood pressure to a greater degree and that the results were more lasting than the injection into the veins of saline solution. The greater efficiency of blood transfusion may be ascribed to the contained colloids.

Transfused blood has been found helpful in many conditions but particularly in hæmorrhage and in shock following hæmorrhage. It was the experience of medical officers during the war, as stated by Primrose and Ryerson, that two definite results may be confidently expected from transfusion: viz., increased coagulability of the blood and increased

[1] Life and Times of Savonarola-Villari.

resistance to infection. It is probable that these two actions of the transfused blood explains its value in cases of gastric hæmorrhage without discoverable cause and in the hæmorrhage of the newborn.

That the hæmorrhage is the result of some infection, the nature of which is not yet understood, seems highly probable. In recent years there has been an increasing tendency to regard melæna neonatorum as a manifestation of a micro-organismal disease. Since Klebs, in 1875, found micro-organisms in the blood and in the tissues in cases of hæmorrhage and especially in melæna, many observers have confirmed his observations, including Weigent, Eppinger, and Rehn. In the blood of newborn children who died of hæmorrhage they found organisms which when injected into young rabbits produced hæmorrhages in them.

The source of the infection remains to be determined. One thinks of the tonsils, the teeth, the gall bladder, the appendix vermiformis and the renal pelvis. Internists and surgeons can recall cases of indigestion, of gastric symptoms simulating duodenal and gastric ulcer, relieved by appendectomy. Over twenty years ago Dieulafoy taught that in many cases of appendicitis, toxins were formed capable of producing jaundice, albuminuria and hæmaturia, and also gastritis and hæmatemesis: and that the hæmatemesis might be severe, recurrent, and fatal. He thought that ulceration of the arterioles lying beneath the muscularis, mucosa was the immediate cause and source of the hæmorrhage. Moynihan has reported cases of gastric hæmorrhage apparently caused by toxins produced in the appendix, and the writer has seen cases of gastric hæmorrhage that did not recur after the appendix had been removed.

Some day some bacteriologist, following the lead of Rosenow will identify and culture a specific germ as the causative agent in these cases of gastric hæmorrhage, in which neither at the operating table nor at autopsy any likely source of bleeding can be found: further, that if a larger experience demonstrates that in these cases the bleeding is arrested by blood transfusions, the logical conclusion would be that the transfused blood has increased the coagulability of the patient's blood and has increased his resistance to infection.

At the bedside, faced by a case of severe gastric hæmorrhage, one may make no mistake in giving a transfusion. At least time is gained for a careful study of the patient, his physical condition, his personal and family history and the operation would put him into a better condition to stand active surgical treatment if found to be indicated.

GROWTH PROBLEMS FOLLOWING OSTEOMYELITIS OF ADOLESCENT LONG BONES[1]

BY KELLOGG SPEED, M.D., F.A.C.S., CHICAGO

ONE of the serious and unhappy results of acute osteomyelitis of adolescent bones is that of growth disturbance. It is my intention to discuss this infrequent phase of acute bone infections from a clinical standpoint, reviewing the excellent experimental work that has been undertaken, dating back to 1872, to offer some practical suggestions for treatment, and to call attention to a few irregularities in the bone pathology. Although most of the experimental work has been directed at the epiphysis, the subject seems not to be confined entirely to derangements of that portion of the bone, as I believed when first studying it. There are few specific references in the literature to interferences in growth after epiphyseal separations. Likewise after acute inflammatory attacks in bone, there are not many reported instances. But the extent of the field involved in the study of interference with adolescent bone growth may be inferred from a few references. Krabbe of Copenhagen[2] in studying 150 children suffering from precocious puberty whose bones were examined by X-ray, found one case of pubertas præcox in which there was a complete synostosis of the epiphyses of the long bones at an age of 7 or 8 years, resulting in marked curtailment of the skeletal growth. He states that there are some 6 other like cases to be found in the literature. No definite inflammatory attack could be traced in these patients. Froelich[3], describing growth epiphysitis, grouped under that head Schlatter's disease, Koehler's disease, juvenile arthritis deformans, trochanteritis, epiphysitis, especially of the fourth and fifth metacarpals, scaphoiditis, and epicondylitis. These conditions all appear at points where the skeleton is very actively growing; they pursue a mild course and are believed to be an attenuated form of growth osteomyelitis. Vulliet[4] reported two instances of lesions of the epiphysis of the calcaneus in boys 11 years of age. These he believed were to be classed with juvenile deforming osteochondritis and Schlatter's disease. The clinical importance of these variously named, mild, bone infections lies in mistaking them for tuberculosis of bone and in a possible misinterpretation of the remarkable efficiency of certain treatments applied. An instance of the relationship of fracture of the lower epiphysis of the tibia to the arrest of growth of the bone was reported by Elmslie[5]. This fracture resulted in arrest of tibial growth and resulting bowing of the fibula which continued to grow normally. A roentgenogram of the involved epiphysis showed that the outer part of the affected epiphyseal area had a normal continuance of growth, while the inner portion showed a marked sclerosis with stoppage of growth. For the acute inflammatory types, we have a report by Hentschel[6] in which he refers to his dissertation (Jena, 1908) and cites an instance of interfered with growth of the tibia following osteomyelitis of the upper end of the bone. He collected a series of cases and was inclined to divide the subject into the following points of clinical interest: (1) shortening of the affected bone, (2) lengthening of the affected bone, (3) defects in the bone, (4) pseudarthrosis, (5) bending and other deformities. McWhorter[7] reported an instance of osteomyelitis with variation in growth of the femur following separation of the distal epiphysis. His patient, 13 years old, had already a shortening of 1½ inches and skiagraphic verification of obliteration of the involved epiphysis. This result followed an infected epiphyseal separation. An instance had been seen by him also in a man 45 years of age who had suffered a bone abscess of the tibia in his twelfth year. There was an increase in the length of the leg

[2] Endocrinology, 1919, Oct. Dec., iii., 3, 459.
[3] Paris mèd., x, xi, 430.
[4] Schweiz. med. Wchnschr., 1920, Dec. 17 l, 1163.
[5] J. Orthop. Surg., vol. 1, 215.
[6] Ztschr. f. orthop. Chir., 1908, xxii, 1647.
[7] Surg. Clin., Chicago, 1919, Dec., 1449.

[1] Read before the Chicago Surgical Society, December 12, 1921 (For discussions, see page 553.)

Fig. 1. The ordinary osteomyelitis of the shaft of the femur in childhood. Involucrum and sequestrum formation have taken place but the epiphysis seems spared. Such a condition requires delicate operative technique to avoid wounding the cartilaginous plate. Prognosis as to growth good.

amounting to 1¼ inches, a stimulating lesion.

Various factors may influence the growth of long bones, of which we may recall: (1) loss of blood supply, (2) disturbances of the endocrine system, (3) inflammation or disease of the bone, especially the epiphysis, (4) trauma of the bone (fracture with or without injury of the epiphyseal cartilage).

The experimental work in this line dates back to Bidder[1]. He inserted needles into the epiphyseal cartilage plate of the bones of dogs, sometimes driving the needles through to the opposite side. Whichever side of the cartilage plate was injured ceased growing, so that bowing or angulation deformities followed in the limb. If the whole width of the cartilage plate was damaged, there was a uniform hindrance of longitudinal growth, the plate becoming replaced by connective tissue or bony trabeculæ. Ollier, Haab, Vogt,[2] and others after experimental investigation made deductions which found acceptance in surgical teaching for many years. By mechanical stimulation of the diaphysis near the epiphyseal cartilage plate, the bone length might be increased and minor lesions of the plate had little effect on the long growth. More extensive lesions or excisions of the cartilage plate resulted in shortening, but when an epiphysis was separated and immediately replaced no interference with growth resulted. When, however, the cartilage plate was fully excised, there resulted complete stoppage of growth at that point.

It was Haas[3] who carefully and quite conclusively investigated two points in the long growth of bones, namely the relation of the blood supply to the longitudinal growth and later the localization of the growing point in the epiphyseal cartilage plate of bones. In estimating the influence of the blood supply on growth, he used the metacarpal and metatarsal bones of dogs. He found that—

1. Ligation and destruction of all the vessels on the dorsal surface of the dog's foot caused no disturbance in longitudinal growth of the metatarsal bones.

2. Cutting off the entire blood supply of the epiphyseal end of a metacarpal or metatarsal bone results in marked lessening of the long growth of the bones even though the main nutrient artery remains intact.

3. If the nutrient artery is destroyed there will be practically no disturbance in length growth, provided the epiphyseal blood supply is not injured.

4. If both epiphyseal and nutrient supply are simultaneously destroyed there will be

[1] Arch. f. Exper. Path. u. Pharmakol., 1873 1, 248.

[2] Arch., klin. Chir., 1878, xxii, 343.

[3] Am. J. Orthop. Surg., 1917, xv, 157; 305; 563.

Fig. 2. Epiphysitis of the calcaneus following acute infection. A sinus developed from the bone to the skin surface. Cured by one operation but the influence on the growth of the bone is as yet undetermined.

greater loss of length than if the epiphyseal vessels alone are injured; in fact, in some cases there is complete cessation of long bone growth.

5. Maintenance of normal longitudinal growth of bone is dependent upon sufficient blood supply to the region of the epiphyseal cartilage plate.

6. Function exerts but little influence upon length growth of long bones.

Haas disputed the possibility of transplanting the epiphyseal ends of bones without disturbing length growth. In his effort to localize the growing point of long bones in the epiphyseal cartilage plate he concluded that—

1. An incision through a growing bone at the junction of the metaphysis with the epiphysis always causes disturbance in growth.

2. A separation in the natural line of cleavage between the epiphysis and metaphysis after incising the periosteum causes some loss in growth.

3. Excision of the metaphysis causes slight disturbance in growth.

4. Excision of the epiphyseal cartilage plate causes practically complete cessation of active longitudinal growth.

5. The most active and important elements necessary for longitudinal growth of bone are located in the columns of cartilage of the epiphyseal cartilage plate.

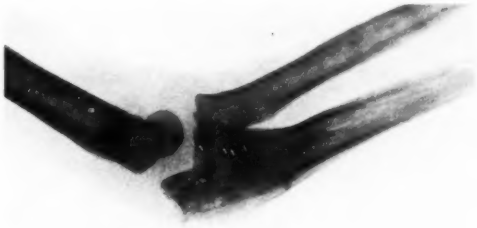

Fig. 3. Osteomyelitis of the upper end of the ulna, involving the epiphysis. Cured by approach through the olecranon without causing pyarthrosis in the elbow. Lack of growth at this point will cause little inconvenience.

6. A limited property of producing length growth is possessed by the cartilage adjacent to the growth columns of cartilage.

In the light of much experimental work in the last 50 years, we may well agree with Haas[1] after accepting as a principal that the most important elements necessary for longitudinal growth of bone are located in the columns of cartilage of the epiphyseal plate that (1) the nearer the injury comes to the cartilage columns, the greater is the growth disturbance; (2) there is also a relation between the degree of destruction of the cartilage columns and the loss of growth; (3) disturbances of direct blood supply of the epiphyseal cartilage plate also have a marked hindering effect on the longitudinal growth of bone.

Acute inflammation of bone, arising either in the epiphyseal area primarily or spreading by continuity from the diaphysis may cause destruction of the cartilage plate and break down its cells to form pus as in acute suppurative osteomyelitis. The neighboring and immediate supplying blood vessels become blocked with thrombi and the normal epiphyseal arteries disappear. Lesser grades of infection as exemplified by Schlatter's disease, non-suppurating epiphysitis, etc., similarly may cause death of the growing cells in the cartilage plate resulting in necrosis without pus formation. In these types also the vascular supply may suffer when such an attack is resolved by an infiltration of round cells. Fibrous tissue usually supplants the growing cartilage cells and bone trabeculæ

[1] J. Orthop. Surg., 1919, i, 67.

Fig. 4. Fig. 5.

Fig. 4. Osteomyelitis of the lower end of the radius with sequestrum formation. The lower epiphysis is involved by continuity, and growth seems to be stopped, inasmuch as the ulna has grown down past the proximal row of carpal bones. Note the radial deflection of the hand.

Fig. 5. Roentgenogram of same case as in Figure 4 some weeks after cautious bevelling of the radius, and drainage. The radial epiphysis appears to have taken on some growth again as the relative position of the radial and ulnar styloids have changed and appear to be approaching normal. The radial epiphysis also appears not to be closed by bony growth. A favorable case which bears watching before any further surgery is attempted. Dr. David.

may grow across the epiphyseal area, completely obliterating the growth power. When the young growing epiphysis is thus destroyed, and the action is rapid, we may compare the end-results after a few weeks to a mechanical destruction or excision of the cartilage plate. There will therefore follow all the phenomena that occur after experimental destruction or excision of the plate, or ruination of its blood supply, namely stoppage of growth or uneven growth resulting from partial obliteration. When the part involved concerns the limb where one bone forms the framework, the loss of length may be compensated by skeletal readjustments and by extra growth effort of the remaining epiphysis in that bone. If, on the other hand, one bone of 2 companions, as in the forearm or leg, ceases growth from one of its epiphyses, the analagous epiphysis of the fellow bone continues to grow and deformities result. The normally growing bone tends irresistibly to push the slower growing bone to one side as it lags behind and as this accident always occurs near joints the articulation may suffer restriction of motion and the whole limb loses a normal axial relation which interferes with function. Decubitus sores ultimately appear over the normally growing bone ends as they force themselves on past the joint (Fig. 12).

A clinical application of these experimental conclusions assumes particular interest where the forearm and leg bones are involved, more especially when *one* of the two companion bones suffers growth disturbance. Arrest or exaggeration of growth of the single bone of the arm is not so important. When one humerus is shortened as compared with its fellow in the other arm, little disability may result and the loss of length may not be noticed by the casual observer. In the thigh there is greater functional disturbance, yet the tilting of the pelvis may accommodate itself to the loss of length in the one leg and there need follow no deformity from overgrowth of a companion bone, none being present. (Fig. 11).

If we accept the conclusions of experimental work which tell us that the greatest interference with long bone growth results from destruction of the cartilaginous plate and the column of growing cartilaginous cells in the epiphysis, the 3 principal clinical conditions which may bring about this interference are fracture (epiphyseal separation), inflammation (osteomyelitis or epiphysitis), and operative removal of the cartilage. The same

Fig. 6 (at left). Osteomyelitis of the lower end of the tibia following open fracture and resulting in stoppage of growth of the lower, least important tibial epiphysis. Note the fibula continues to grow and is causing a bowing deformity of the leg. The osteomyelitic focus is quiet and apparently healed.

Fig. 7. Lateral view of the same leg as in Figure 6. A slight drop foot is present.

Fig. 8. Roentgenogram of two planes of the leg, same case as shown in Figures 6 and 7. The inferior tibial epiphysis appears to be completely obliterated and replaced by bone. A more slowly filling bone cavity exists in the metaphysis. In addition it is seen that the fibula has developed a cross union to the tibia. This followed an osteotomy to straighten the leg and has helped guard against the further bowing of the leg by holding the two bones together. Note the increase in the size of the lower half of the fibula because it is now bearing much of the body weight. The inferior fibular epiphysis is still ununited and the bone has grown down to the calcaneus past the ankle.

experimental work confirms our clinical knowledge that interference with the shaft of the bone (diaphysis) by fracture, surgical removal or inflammatory process even when the nutrient blood supply is destroyed, does not interfere with adolescent long bone growth. As the epiphyseal blood supply has a strong influence on growth, we must take operative precaution to preserve these vessels, especially those leading to the *epiphysis of greatest growth* in a bone.

However, we are confronted by some apparent inconsistencies in the application of this fact, as in one case after a patient suffered a fairly well-localized osteomyelitis of the diaphysis following open fracture of the radius which did not include the epiphyseal area, an arrest of growth resulted (Fig. 14). X-ray examination after 2 years failed to reveal in this patient that the epiphysis was closed, or that it differed roentgenologically from its analogous epiphysis in the other wrist. The osteomyelitic focus became healed following operation, and the bone was slightly sclerosed about the healed area, but the long growth did not proceed in a normal rate. Experimentally, a lesion at this site in the shaft of the bone would have little or no effect on the rate of growth; clinically, it did have. We must seek the cause in another direction. It may be found possibly in an assumption that the vessels leading to the nearby epiphysis became thrombosed and obliterated by the septic process, and pending the time when vicarious circulation might be established, the epiphysis in question ceased growth. On this account the deformity was treated conservatively with an expectation that growth would ultimately return to the area (Fig. 15).

Yet another pathological factor enters into the clinical interpretation of some of the instances of growth stoppage, and has great bearing on function and treatment. Atten-

Fig. 9. A similar instance involving the inferior epiphysis of the tibia, now healed. From a growth standpoint it is fortunate that the fibula has been nearly obliterated and offers little support or tendency to cause bowing or other deformity.

tion is called to cross union between two bones in an extremity, particularly the forearm.

Fig. 10. Osteomyelitis of the radius following open fracture, healed. The lower radial epiphysis, although distant, seemed to stop growth. On its outer aspect it seems not to be obliterated. A cross union has taken place between radius and ulna, fortunately at a level too low down to influence pronation and supination. The ulna, however, on account of this union has been unable to produce bowing deformity as it is anchored to the radius and each bone is growing equally from its respective upper epiphysis. The lower ulnar epiphysis has grown on down nearly to the metacarpal bones.

Fig. 11 (at left). Osteomyelitis of two years' standing, healed. The upper epiphysis of the tibia has been involved and the leg as a whole is shortened from the knee down. Pelvic tipping and scoliosis accommodate for the shortening. The foot is in fair weight-bearing position.

Fig. 12. Lateral view of the leg in Figure 11. Note that the fibula has continued its growth. In this leg the most important epiphysis has been obliterated and in contrast to Figure 7 the shortage of the leg is more marked. Splinting has saved much bowing of the leg, but the extremities of the fibula are growing beyond their respective joints and the pressure on the skin over the protruding bone ends threatens necrosis.

Following the septic process which usually involves the epiphyseal cartilage plate, a deposition of bone may pass through the tissues or across the interosseous ligament to unite firmly the two bones by an osseous band. This is cross union (Fig. 10).

When the bone which has suffered destruction of its epiphysis heals it is found firmly united to its fellow by cross union. This in the forearm may interfere seriously with pronation and supination. As the fellow bone continues to grow it has less tendency to produce a bowing of the forearm, but as it grows down past the carpal bones it causes a more marked deflection of the wrist, and that coupled with the loss of rotation entails a greater disability. The treatment we suggest is also less promising in this class (Fig. 8). Multiple joints in the same patient may be involved in growth disturbance.

Fig. 13. Healed osteomyelitis of the radial shaft following infected open fracture. The lower radial epiphysis has stopped growth and the projection of the ulnar styloid downward past the wrist is clearly seen. Considerable functional loss.

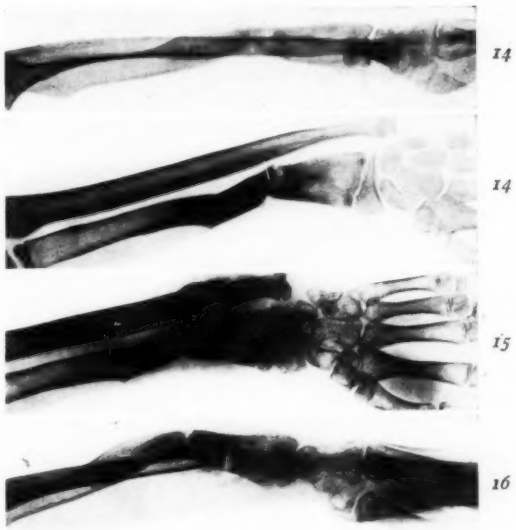

Fig. 14. Roentgenogram of the forearm in Figure 13. It can be seen that the inferior epiphysis of the radius does not appear closed but the ulna has grown well down below the wrist joint.

Fig. 15. Postoperative roentgenogram of forearm in Figure 13. Note the site of resection of the ulna, its union, and the retraction of the ulnar styloid to its normal level. If cross union were present this could hardly be performed. The lower radial epiphysis does not seem to be obliterated by bone but growth has ceased in it for more than 2 years. Obliteration of the epiphyseal vessels may account for its lack of growth.

Fig. 16. Lateral view of the forearm in Figure 13 after operation. Viewing across the wrist joint shows the normal level of the articular surfaces of the ulna and radius. The patient awaits further evidence of stoppage of growth in the lower radial epiphysis after which the lower ulnar epiphysis may be excised and the two bones will then grow evenly.

TREATMENT

Because no amputations have been performed for this type of deformity, it has been impossible to obtain specimens of human bone for study. An effort is always made to alleviate the condition in leg or arm without causing further injury. The treatment may be divided into prophylactic and active. Prophylactic treatment concerns:

1. Early operation on shaft osteomyelitis of adolescent bones before the epiphyseal areas become involved or their vessels thrombosed and obliterated.

2. Extreme conservatism in draining acute suppurative epiphysitis of adolescent long bones.

a. Cut open the periosteum by means of one longitudinal incision; do not reflect it any more than necessary;

b. Never use a sharp curette in the epiphyseal area; wipe out granulations and drain;

c. Immobilize the limb in a suitable splint or dressing; best with some traction in extension so that a pathologic dislocation may not follow, also so that drainage will be efficient.

3. Warn parents of possible growth interference and examine patients frequently with X-ray after healing takes place.

4. If growth seems arrested, apply suitable splint or apparatus to prevent deformities while waiting for growth to recommence. This means in the leg especially a provision against early weight bearing without proper caliper support.

5. Protect skin over growing ends of healthful companion bone, so that pressure sores and infection may not develop.

Active treatment. Although these problems most generally concern arrest of growth and occur in adolescents, the principles of treatment suggested might apply to overgrowth or to the correction of deformities in the adult. One must consider the age of the patient. The surgeon who undertakes a curative or palliative operation must bear constantly in mind the remaining years of growth as well as the actual number of inches of growth that await the patient. In the leg this is especially important because weight bearing on a limb deformed from this cause may be seriously interfered with by mal-

positions of the foot from local length changes, by infected pressure sores over the ends of the normally growing bone, and by changes in gross length of the limb which lead to pelvic tilting, scoliosis, and change of gait. I have adopted therefore the following rules of treatment:

1. Remember the law of nutrient arteries in relation to growing long bones, i. e., the nutrient arteries are directed toward the elbow and from the knee, and the epiphysis toward which the artery is directed unites first. The fibula is an exception, of course. Consequently, the lower epiphysis of the femur, the upper epiphysis of the tibia, the lower epiphysis of the radius and ulna, and the upper epiphysis of the humerus all unite last in their respective bones and must be the most guarded.

2. Unless a bowing deformity in the leg or forearm tends to manifest itself rapidly and to cause great loss of function or threaten skin necrosis, splint correction of the extremity for at least 1 year is favored.

3. If both clinical and X-ray examination during the course of the year show that the bone is arrested in growth, a shaft resection of the companion bone, remote from the epiphysis, is performed to equalize length. Simple means (kangaroo tendon) of holding the resected ends in apposition are used, followed by a firm splint until union takes place.

4. If the child is young (many years and inches of growth expected), after 2 or 3 years when it is quite positively established that the epiphysis of the damaged bone has ceased all growth and is obliterated, the analagous epiphysis of the fellow bone may be excised (epiphysectomy) to stop its overgrowth. Each bone then grows at an equal rate from the remaining epiphysis and there is no fear of subsequently appearing bowing deformity. Length deformity will persist.

DELTOID PARALYSIS AND ARTHRODESIS OF THE SHOULDER JOINT

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The Clinic

PARALYSIS of the upper extremities from all causes, the muscles being involved singly or in combination, is not as frequent as paralysis of the lower extremities. Paralytic conditions affecting the leg generally induce a patient to seek medical relief more readily than do those of the arm, for two reasons: (1) the lack of locomotion is felt more keenly than is the inability to perform certain manual tasks for which, after all, two limbs are available; (2) the therapeutic results, as far as the upper extremities are concerned, are on the whole not as striking and satisfactory as those on the lower extremities, which is mainly due to the fact that in the former case we have to deal with more highly complicated and specialized organs.

The foregoing facts explain why our orthopedic records show two or more lower limb cases for every arm case. Incidentally we have enumerated the chief reasons why the isolated deltoid paralysis is a rather rare object for treatment by the orthopedic surgeon.

The picture of this lesion (the changed contour of the shoulder, undue prominence of the acromion, coracoid and humerus head, subluxation of the joint, inward rotation of the arm, the flail shoulder with the limb a practically useless appendix of the body) is all the more lamentable, since the well-preserved function of the forearm and hand is rendered worthless through the inability of the patient to move them to the desired place of action. Another point which is generally not sufficiently evaluated is the fact that, through continuous overtension of the flexors and extensors of the upper arm, in the course of time, these muscles become as useless as the deltoid itself and serve to augment the misery.

The treatment of both the recent and old condition may be divided into three categories; the preventive, the palliative, and the curative. While the first is said to confine itself to the prevention of complete paralysis by electricity, gymnastics, and massage, restoration of a completely paralyzed deltoid by these means must at least remain doubtful. In the cases reported we probably have to deal with only partial degeneration or with vicarious action of auxiliary muscles, especially the supraspinatus.

All preventive measures must necessarily end in fiasco, if they are not preceded or assisted by correction of the subluxation and overstretching of the muscles surrounding the joint. Therefore the wearing of a Schuessler aircushion apparatus or one of the appliances devised by Hoffa (1), Billroth and others, is indispensable. However, braces of any kind have one important disadvantage. Besides failing to provide the lost deltoid function, they interfere seriously with the substitution of this function by the muscles of the shoulder girdle. Thus the palliative treatment as attained by orthopedic apparatus of Hoffa, Vulpius (2), Silver and others, fixing the shoulder joint in a prearranged and, as far as the forearm and hand are concerned, most advantageous position, naturally must remain nothing but a poor substitute for methods to be discussed later.

Consequently, while the medico-mechanic treatment, as applied to recent or partial deltoid paralysis, often may be used with more or less success, inveterate cases must be subjected to surgical procedures. The methods in question are curative in the sense that they either provide the paralyzed deltoid with a new nerve supply (as by nerve grafting) or supplant the lost muscle action by another muscle (muscle transplantation) or they substitute the muscles of the shoulder girdle as a whole, after union of the humerus and scapula—arthrodesis.

The nerve graft has been applied in different variations: fifth into sixth cervical, by Harris, and Low (3); median, ulnar, and radial into axillary, by Vulpius Stoffel (4); subscapulary into axillary, and fifth into seventh cervical. Lengfellner and Frohse (5), and especially Stoffel, have made minute investigations into these conditions and have put the deltoid nerve surgery on a firm anatomical and physiological basis. But, as far as the results are concerned, they leave much to be desired. The applicability only to fresh cases with little degeneration, the long time of waiting for success, the complicated after-treatment, and then, in the best event, a rather weak deltoid action, do not elevate the nerve transplantation very much above the results obtainable by medico-mechanic therapeutics.

The muscle or tendon transplantation offers the second possibility of replacement. In 1892 von Winiwarter made the first attempt at replacing a paralyzed deltoid by a part of the pectoralis major with a moderately good result. Later Hoffa (6) used a part of the trapezius. So did Bradford (7), Dean Lewis (8), and Tubby (9). The cuts illustrating Hildebrandt's method (10), in every book on surgery, vouch for this author's success. Lengfellner and Frohse (11) also investigated this subject extensively with results which are well worth studying by one interested in these procedures. Only the uncertainty of the results and the magnitude of the operation with its resulting scars and deformation leave not much room for doubt that for some time to come, a much simpler operation with more positive results will be the method of choice. I have in mind the arthrodesis of the shoulder joint.

The development of the shoulder arthrodesis operation dates back as far as 1879, when Albert (12), the inventor of the principle of the arthrodesis operation, applied it in the case of a young girl. After him Wolff (13), Karewski (14), Hoffa (15), Bothézat (16), Vulpius (17), McMurray, Naughton Dunn (18) and others (19, 20, 21, 22, 23, 24) have done the operation with more or less satisfaction. The earlier operators failed to achieve bony union and therefore considered the shoulder joint not a very favorable subject for arthrodesis. Hoffa (15) says pessimistically: "The arthrodesis of the shoulder joint in any case must remain the *ultimum refugium* and can only be recommended as such. A true ankylosis cannot very well be produced by it." This latter

Fig. 1.

Fig. 2.

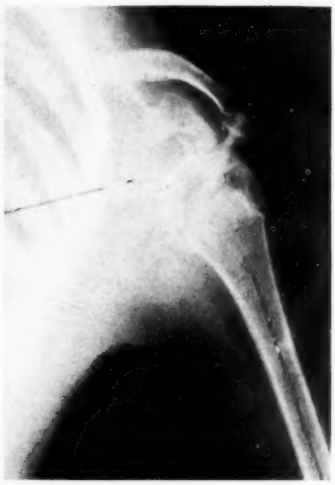

Fig. 3.

Fig. 1. Left isolated deltoid paralysis and flail shoulder, after poliomyelitis. Changed contour, atrophy of deltoid, and secondary wasting of upper arm muscles are marked. Upward displacement of left shoulder by trapezius action (assigned by some authors to the operation itself and urged as an objection) is here shown to exist prior to operation.

Fig. 2. Ante-operative roentgenogram, showing subluxation of shoulder joint.

Fig. 3. Postoperative (12 weeks) roentgenogram of shoulder joint. The humerus is firmly united to the scapula, the bony fusion in the glenoid fossa is shown, the osteogenetic process is creeping up along the bone peg, toward the acromion. No absorption is found about the peg. The angle made by the outer edge of the scapula and the humerus is slightly more than 90°.

sentence hits the crux of the whole situation. If we desire an excellent and permanent result, we must avoid fibrous union by all means. Fibrous ankylosis interferes considerably with the endurance of function, the fibrous tissue not being able to stand the wear and tear. Fibrously ankylosed joints easily become tired even to the degree of painfulness and are much liable to subsequent contracture. More in the shoulder joint than in any other, only a sufficient bony fusion will meet the ideal purpose of the operation, which is to transfer motion, abduction, flexion, extension, and rotation from the muscles of the shoulder girdle through the scapula to arm and hand, a task involving considerable leverage, torsion and side strain, especially in case there is any weight to be handled by the arm. This statement is clearly borne out by a review of the cases operated upon, in so far as patients with proven bony union in correct position also show the best functional results. No wonder then, that surgeons in latter years, trying to free themselves from the pessimistic attitude of the earlier operators, see in bony fusion of the joint the ideal of the procedure and use every means of scientific advancement to attain their aim. In order to show how this is done with the outlook for a good result, a description of a typical operation for arthrodesis of the shoulder joint, used by myself, is given, followed by a discussion of the essential points, with a few illustrations at hand.

The essentials of a good technique are large access to the joint and firm fixation in the proper position. The paralyzed deltoid does not need to be considered. Generally it appears as a thin platysma-like, degenerated structure. The circumflex nerve also does not require consideration.

The operation is done as follows:

1. An incision 4 inches long is carried from a point half an inch internal to the acromioclavicular joint downward to the outer side

Fig. 4.

Fig. 5.

Fig. 6.

Fig. 4. Postoperative view of patient, showing absence of scoliosis and position of scapula.

Fig. 5. Postoperative view of patient immediately after removal of plaster cast (12 weeks) showing strength of union; arm is held in horizontal position, and is unsupported.

Fig. 6. Postoperative view of patient, showing range of excursion that makes eating, hairdressing, etc. possible.

of the pectorodeltoid groove, embracing skin, fat and deltoid.

2. The joint is opened alongside and internally to the biceps tendon from the tuberculum supraglenoidale to the insertion of the capsule on the collum anatomicum.

3. Lift the tendon out of the sulcus intertubercularis and displace it laterally.

4. Now the capsule is dissected off the anatomical neck, backward and forward, rotating the arm inward and outward, until broad access to the joint is gained and the head of the humerus can be conveniently dislocated. The synovia then is excised and curetted away as thoroughly as possible, under careful observation of the integrity of the biceps tendon.

5. Rotate the arm strongly outward pushing the head of the humerus far out of the wound. With knife and rasp remove all cartilage down to the spongiosa. Subject to the same process the glenoid cavity, not only in its center, but also the borders, right out to the labrum glenoidale, carefully preserving the insertion of the biceps tendon. Vivify the lower surface of the acromion. It is polypragmaty to do the same with the coracoid process.

6. With an assistant fixing the scapula in normal position return the head into the capsule and in close apposition to the glenoid cavity and the acromion. In order to give the patient the most use of his hand the joint must be ankylosed with the humerus at about right angle abduction to the body, viz., the external border of the scapula from 80 to 110 degrees to the axis of the humerus, somewhat rotated inward and slightly flexed. This is the position by which the hand not only can reach the mouth, head and neck, but also the upper arm later will comfortably touch the lateral chest wall, while at rest.

7. With the arm in this position a hole is drilled through the acromion into the center of the humerus head, the drill left in place, a small dowel-peg secured from the tibia and, after removal of the drill, driven into the hole.

8. Now the smooth intertrochanteric groove, to the extent of about one inch, is transformed into a rough bony trough, by lifting up a bone-periosteum door, into which the biceps tendon is buried, with the door fastened over it by kangaroo tendon sutures; in other words, a tenodesis is performed.

9. Close the wound with fine catgut in layers, taking up the slack in the capsule.

10. Immobilize over aseptic dressings by a plaster cast embracing chest, shoulder operated on, extending to the middle of the

forearm, with the elbow in flexion, such immobilization to last undisturbed for 12 weeks.

The main points of the operation described are: first, most thorough removal of the synovialis; second, the most radical removal of all cartilage down to the spongiosa; third, the strict avoidance of all foreign non-absorbable fixation and suture material; fourth, the use of the upper part of the biceps tendon for a fixation purpose.

As to the first point, Sir Astley Cooper (25) a hundred years ago has drawn our attention, among other causes for non-union of intracapsular fractures of the hip, to the detrimental action of the joint fluid, which forces its way between the fragments and thus efficiently prevents union mechanically and possibly in other ways. Others (26, 27, 28) from time to time, have enunciated the same fact. There is no reason for the belief that conditions in the operation under consideration (or in fact, in every arthrodesis) are not greatly similar. Consequently we must prevent the secretion of synovial fluid. This can efficiently be done only by the thorough excision of the synovial membrane.

The second important point of the operation is the removal of all cartilage. It is a well-recognized fact in bone surgery that the extensive contact and unobstructed access of the medullary osteoblasts to the scene of action make for success, while interposition of fibrous or its relative, cartilaginous tissue forbode delay and failure. Thus, from a mechanical as well as a physiological standpoint, extensive adaptation of the former joint surfaces, denuded of all cartilage, is essentially necessary.

As to the third point, the choice of fixation material, I have been fully converted to the view of Albee (29) who does not use non-absorbable material for the reason that it is conducive to irritation of the tissues, bone destruction, inhibition of bone growth, lowering of vitality and subsequent infection. Consequently, the use of wire, as applied by many surgeons in the past, is, to my mind, a surgical sin, which ought not to be committed in the presence of physiologically correct material. In the case *sub judice* autogenous bone graft and kangaroo tendon will satisfy the taste of the most fastidious operator and their use cannot be recommended highly enough. The fixation by bone graft dowel peg, a child of the inventive mind of Albee, is recommended and used by this author also, in the arthrodesis of the shoulder joint. It not only furnishes an excellent means of firm fixation, but also stimulates osteogenesis and osteoconduction eventually leading to a strong union between humerus and acromion which can not be obtained in any other way. Most of the other authors have used wire or silk. In this respect it is interesting to hear what Lange (30), one of the most ardent investigators and advocates of foreign body implantation has to say. According to this author tin (stannum) is the metal most acceptable to the tissues, while all other metals, especially silver, lead to severe irritation. "Silk may easily and as a rule permanently heal in, after it has been boiled in a solution of hydrargyrol oxycyanide 1:1000." But why, I ask, use these materials, after the non-irritability of autogenous bone and kangaroo tendon has been proven beyond doubt by practical use in hundreds of cases?

The innovation of the intra-osteal tenodesis in this operation has suggested itself to my mind for the reason that after the arthrodesis there is no more use for a sliding tendon over the shoulder joint. Thus the point of origin of the biceps tendon may just as well be transferred onto the upper end of the humerus and the supra-articular portion of it used for the strengthening of the superior circumference of the arthrodesis, where the strain is greatest. This arrangement incidentally makes for the most advantageous working of both Roux's and Wolff's laws, thus securing the ideal of the operation, bony union.

Under point five of the description of the operation I have thought it superfluous to pay any attention to the coracoid process as advised by a number of surgeons. A look at the anatomical conditions will tell the reason. It is hardly possible by any manœuver to bring the head of the humerus into apposition with the glenoid fossa, the acromion and the coracoid process at one and the same time, unless one chooses to fracture the acromion.

as one author suggests. This in my mind is an unnecessary act and out of proportion to the advantage gained.

The question, as to when the arthrodesis of the shoulder joint is indicated, from the foregoing may be easily answered. Any case of flail shoulder, with fairly well preserved spino- and thoracoscapular musculature is a fit subject for the operation. In addition it may be mentioned that in the interest of the upper arm muscles it is desirable to operate on these cases, before overtension and the atrophy of inactivity have had their telling effect; in other words, as soon as the fact of a permanent paralysis of the deltoid is well established.

Failure, complete or incomplete, in the outcome of the operation, which means lack of humeroscapular fixation or uselessness of the arm, will be extremely rare, as long as the operation is done after proper evaluation of pre-operative conditions and with careful observation of the technique described.

Among the disadvantages of the procedure have been mentioned: the formation of fistulous tracts with the expulsion of the foreign materials used, an objection which is void with the use of the technique discussed; second, two disadvantages of a cosmetic nature, the upward displacement of the scapula by trapezius action (Fig. 1) and the supposed secondary scoliosis. Both of these latter points have been proven to be without significance by Vulpius (31).

Accordingly, we see that the advantages of the operation, which may be summed up by stating that a useless extremity of the body is reinstated and a hopeless condition for all practical purposes cured, far outweigh the only real disadvantage, viz., the creation of a pathological condition by stiffening a movable joint.

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HUMAN ACTINOMYCOSIS

With Special Reference to Source and Mode of Infection

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ALTHOUGH the disease "lumpy jaw" in cattle was first described by Le Blanc in 1826, it was not until 1877 that Bollinger and Hartz discovered the specific micro-organism and gave to it the name actinomyçosis bovis. Israel and Wolff shortly afterward isolated the same organism in pus of an empyema in the human subject. Since the discovery of Wolff and Israel, there have been many and varied human manifestations of this disease reported in the literature. This is especially true for the past decade due in a large measure to the fact that many of the earlier cases went undiagnosed, though some investigators believe that this disease is gradually becoming more prevalent in this country.

BIOLOGICAL CHARACTERISTICS

Widely different descriptions of the biological characteristics of the specific micro-organism have been reported. The first extensive biological studies were made by Bostroem (1), who, in 1890, published a report of cultures from 11 cases of actinomycosis of the jaw in cattle. The micro-organism obtained from each of the cases apparently belonged to one species. This micro-organism he describes as one which grew best under aerobic conditions on all culture media in the form of masses of branching filaments forming nodular membranes or layers which assumed more or less of a reddish color. In old cultures the surface of growth became white in color and this change in color corresponded to the transformation of the superficial filaments of the growth into rods and round coccus-like bodies. These coccus-like bodies he regarded as of the nature of spores. The organism grew at room temperature on all media and even on sterilized water.

Wolff and Israel (2), one year later, report having isolated from two cases of actinomycosis in man an organism with totally different cultural characteristics from that of Bostroem. The organism they isolated grew best under anaerobic conditions and did not grow at room temperature. Its growth was much less luxuriant than that of the Bostroem organism. Animal inoculation gave the typical lesions of actinomycosis in each instance.

Wright (3), in 1905, reports results of a biological study of micro-organism of actinomycosis which closely parallels the work of Wolff and Israel. He isolated the organism in pure culture from thirteen cases of actinomycosis in man and from two cases in cattle. These micro-organisms he believes to be all of one species as the difference among the various strains were no greater than among the various strains of tubercle or diphtheria bacilli. He found the organism to be essentially an anaerobe which grew well only in agar and bouillon cultures and in the incubator. In other culture media and at room temperature its growth was slight or not at all. The clubs of actinomycoses were produced only by immersing colonies of the micro-organism in animal fluids, such as blood serum and serous pleuritic fluid. He found all the strains studied capable of forming the characteristic club-bearing colonies in the tissues of experimental animals inoculated. As a result of his study he concludes that but one species of micro-organism is the characteristic infectious agent in typical actinomycosis and that is one with the properties and characteristics of the organism he has described. He does not accept the work of Bostroem, because Bostroem did not show an agreement in morphological and biological characters between the micro-organism of the cultures and the micro-organism of the lesions, as he did not reproduce in his cultures characteristic pathogenic action upon animals as his animal inoculation experiments failed to reproduce the lesions of actinomycosis.

In view of the fact that Bostroem found the micro-organism in only a very small pro-

portion of his cultures, Wright believes it highly probable that the organism described by Bostroem to be due to a contamination by one of the nocardia group which differs widely from actinomycosis in having spore-like reproductive elements and being widely disseminated in the outer world. That a nocardia ever forms the characteristic lesions of actinomycosis in man or cattle has never been convincingly shown, and therefore infections by these organisms he believes should be called nocardiosis and not actinomycosis; the latter term he would reserve for all cases of infection with the true actinomycosis bovis micro-organism.

There are many other published reports bearing on the biology of micro-organism of actinomycosis, most of which show much which is contradictory and confusing. Some writers believe the disease is due to infection with two or more distinct species of micro-organisms while others believe that only a single species is concerned. Further confusion has been brought about by some writers who have classed with antinomycosis certain other suppurative processes which differ from typical actinomycosis by absence of sulphur bodies, and which are known as pseudo tuberculosis or cladothrix infections. On the whole, the work of Wolff and Israel seems to have been most uniformly accepted and has been confirmed by careful and painstaking studies by Wright and others in late years.

ORIGIN AND MODE OF INFECTION

Because this organism does not grow well on all ordinary culture media and practically not at all at room temperature, Wright does not believe that it has its usual habitat outside of the body but that it is very probable that it is a normal inhabitant of the secretions of the buccal cavity and of the gastro-intestinal tract both of man and animals, though he has no proof to substantiate this theory. He believes that the part played by foreign bodies so often found in actinomycotic lesions is not that of carrier of the micro-organism into the tissues from without, but that the foreign body by its traumatic irritative effect furnishes a nidus in tissues, through which infection takes place from organisms normally present in the secretions of buccal cavity and gastro-intestinal tract.

In view of the observations of Wright, and the lack of any evidence that actinomycosis was a contagious disease, Lord (4) investigated teeth and tonsils as a source of infection. From the contents of carious teeth and tonsillar crypts of patients without actinomycosis he made intraperitoneal inoculations of guinea pigs, and succeeded in producing omental tumors histologically identical with actinomycotic tissue and containing typical club-bearing actinomycetic granules in three out of five animals inoculated, or 60 per cent of the inoculations in both instances. This he believes indicates the buccal cavity as the source of the disease. In explanation of the infrequency of the disease compared with the numberless chances for infection he cites five negative inoculation experiments in his series, in which organisms resembling actinomycetes were present in the smears from the extracted material, the organism having failed to multiply in the body of the animal, due as in other infections to the varying numbers and vitality of the seed and fertility of the soil. Another factor of probable hindrance to infection he believes is the number and virulence of organisms occuring as a mixed infection with actinomycetes.

That Lord by his work has demonstrated that the organism of actinomycosis may be an inhabitant of the oral cavity in cases showing no clinical manifestations of the disease cannot be questioned; however, it does not materially strengthen the theory of Wright that this organism is a normal inhabitant of the oral cavity and gastro-intestinal tract. The fact that true dichotomy sometimes occurs in leptothrix according to Israel, renders it impossible at times to differentiate leptothrix from the streptothrix forms of actinomyces; in fact he reports having found forms in colonies of leptothrix from dental mucus, which had analogous growth to the clubbed bodies of actinomyces, but differing in having no radial arrangement. The possibility of Lord having dealt with this organism in his negative inoculation experiments is open to consideration.

It would hardly seem possible that the organism of actinomycosis could exist as a normal inhabitant of the oral cavity and gastro-intestinal tract without giving rise to pathological manifestations more frequently than it does. The dentist and oral surgeon would surely encounter this disease quite frequently following manipulations about teeth and oral cavity causing abrasions of gums and oral mucous membranes, a predisposing condition to infection—yet such infections are unheard of. Likewise in surgery of the gastro-intestinal tract, the same holds true. Never in all the thousands of operations performed at the Mayo Clinic, has there been a single case recorded of postoperative infection by this organism. Neither do we find a single case reported in the literature where such infection has taken place.

There is much evidence pointing to a source of infection originating outside of the human body. Most writers are agreed that the organism when not living as a parasite on man and other animals is essentially either a saprophyte living in the soil, or parasites of higher forms of vegetable life.

Some observations have recently been made at the Agricultural Experiment Station at Geneva, New York, by Conn (5), who by culturing various soils has shown that actinomycetes average about 38 per cent of the total flora of sod soil, and only 20 per cent of the total flora of soil under cultivation, or nearly twice as plentiful in sod as in soil under cultivation. He has also shown that the number of actinomycetes in sod soil increases as the sod grows older. He states that observations are at hand indicating that actinomycetes occur in the soil not as filaments, but as chains of short rods or cocci closely resembling ordinary bacteria. Considering this as the normal mode of growth of this organism in the soil he gives two explanations for his findings. One is that sod soil is more favorable for growth of the organism under anaerobic conditions. He, however, did not find a decrease in the actinomycetes by aerating the soil. The other explanation which has been considered is that the actinomycetes are active in the decomposition of grass roots or perhaps of plant roots in general.

Liebman has been quoted by Chretien (6) as having performed some interesting experiments on seed inoculations with actinomycetes. He inoculated the seeds of beans, lentils, and barley, and the plants and the parasites developed simultaneously. The plants were invaded by short rod like bodies, and by forms of the fungus found in animals as well. He was able to infect animals from these and also succeeded with his inoculations into other media. He also pointed out that the streptothrix actinomycotica becomes attenuated by passing through the animal body, but regains its virulence after being grown on a plant.

The observations of Conn and of Liebmann are of interest when applied to the reported endemics of actinomycosis among cattle fed on grain from certain fields. Jensen (7), a veterinarian, reports an endemic of actinomycosis in Seeland due to eating rye grown on newly cultivated soil reclaimed from the sea. He mentions an instance of a farm, where nearly the whole of the young stock, about thirty in number had actinomycosis after feeding on mixed forage grown on a certain field. Two years later the same disease occurred in the same stalls in four animals after being fed on barley straw from the same field.

According to Jensen the fungus grows on grain, husks, and straw of different cereals, but most abundantly on barley, which is also the most likely to wound the mucous membrane. Johne's (8) observations tend to corroborate this view, for in twenty-two out of twenty-four cases in which he found barley sticking in the tonsils of pigs, he found the beard thickly beset with a fungus very similar to, if not identical with, the ray fungus. Bostroem found the remains of grain or its sheath in lesions of eleven of his cases. Numerous observations similar in nature have been made since.

McKenty (9) has likewise noted the endemic nature of the disease, in reporting thirty-seven cases of human infection at the Royal Victoria Hospital at Montreal. He states that with the exception of three or four cases they all come from locations within a hundred miles of Montreal. One small

strip along the St. Lawrence River furnished a large number of the cases, and the other locality was south of Montreal and in the Eastern townships. Older writers frequently speak of endemics occuring in the salt marshes of Europe, as well as newly cultivated lands reclaimed from the sea.

That grain and grasses play an important rôle in human infections as well as in animals has been convincingly shown clinically.

Soltmann (10) reports a case of infection in a boy 11 years old as a result of swallowing an awn of wall barley. The boy became very ill and suffered great pain behind the sternum, extending to the back. An abscess formed, covering an area extending over six intercostal spaces, and when opened the awn of barley was found in the evacuated pus. A subsequent examination of the pus showed infection to be actinomycosis.

A similar case is reported by Cope (11) in a boy of 10, who accidentally swallowed a blade of grass which lodged in region of right tonsil. Subsequently a swelling developed behind the angle of the right jaw. In a month's time softening occurred and abscess upon being opened discharged typical sulphur bodies. Later the piece of grass was discharged through the sinus.

In many cases where infection has taken place without grains or grasses acting as foreign bodies, there is a history of the patients having been habitual users of straw or blades of grass and hay as toothpicks or have habitually carried them in their mouth. Poncet reports such a case where the patient, an old woman, carried wisps of straw in her mouth with which to tie up the vines in her vineyard.

Maas (12) reports two interesting cases of infection from chewing grain. The patients were both strong and robust young men who, prior to their illness, were occupied in unloading a stranded wheat steamer in Lake Erie and frequently chewed the raw grain. Both subsequently developed actinomycosis in the cervical region. A parallel case is reported by Leith whose patient carried raw grain in his pocket to chew on at odd moments.

Hummel (13) reports a case of actinomycosis of upper jaw caused by a piece of oat chaff which had evidently entered through mucous membrane of mouth. He states that twelve other cases have been reported in the German literature in which the infection was found to be due to a foreign body, usually a piece of barley-corn or some other kind of grain.

Thus it would seem that clinically at least grains and grasses are well established sources of infection in human actinomycosis as well as among cattle. That the nature of the soil on which grains and grasses are grown is a factor in its ability to produce infection also seems plausible, in view of the reported endemics among cattle and the experimental evidence of Conn and of Liebmann.

Since Wright by his cultural experiments has shown that the organism of actinomycosis, as found in man and lower animals, is not capable of existing in the outer world, it seems highly probable that this organism must be capable of a dual existence. In the outer world its existence is that of a soprophyte in the soil, which under certain conditions is capable of becoming parasitic upon higher forms of vegetable life, and in this state it assumes its pathogenicity for man and lower animals. Once it gains access to the tissues it becomes attenuated and assumes totally different cultural and morphological characteristics, which are not in keeping with its existence in the outer world. Whether or not this dual existence is due to the fact that the actinomyces organism is a spore former, is a mooted question among bacteriologists. The bulk of the evidence seems to favor the belief that it is not a spore-forming organism, but a true fission fungus which may be looked upon as a link between the bacteria on one hand and the lower fungi on the other. This in a larger measure seems justified by the habitat of the organism.

Direct transmission of this disease to man from lower animals has been denied by many observers. While direct inoculation experiments from man to lower animals have been successful there has not been a single case recorded in the earlier literature in which direct infection from lower animals to man took place. This is in keeping with our

knowledge of the parasite, since Liebmann has shown that the organism loses its virulence in passing through animals. There have, however, been a few cases reported in this country which would seem to show that direct infection is possible. Such are the two cases reported by Ochsner, one of whom drove a horse afflicted with "lumpy jaw" and the other a cattle dealer who frequently handled cattle affected with the disease. There is but one case on record in which direct infection from man to man has taken place. McKenty reports such a case in which a Royal Victoria Hospital nurse was infected by a patient with actinomycosis under her care.

That infection may take place by mere contact seems to have been definitely ruled out by Salmon (14) who put twenty-two healthy cattle with infected ones for a period of four months and not one of them developed the disease. Milk infection seems highly improbable as the mamæ of cattle are rarely infected and the disease is practically unheard of among infants. That infection may take place through improper meat inspection seems also out of the question as the ordinary process of cooking destroys the organism. Israel is satisfied that this means of infection can be ruled out, as he has noted the disease in many strictly orthodox Jews, who exercise extreme care in examining cattle intended for food. In view of such convincing evidence it is no wonder that many observers are inclined to disregard the possibility of transmission of this disease to man from lower animals. That it does take place, however, and more frequently than we have hitherto been led to believe, is manifest by the results of investigation of this series of cases.

The following questionnaire was prepared and sent to each of forty cases which had been treated at the Mayo Clinic prior to January 1, 1917.

1. Have you ever in any way come in contact with horses or cattle afflicted with "lumpy jaw" or any disease simulating it, such as old ulcers or swellings about the animal's head or neck?
2. Have you been in the habit of chewing on straws or blades of grass or picking your teeth with same?
3. To what extent have you eaten of fresh uncooked vegetables such as lettuce, celery, etc?
4. Have you at any time had decayed teeth or other tooth troubles?
5. Are you now, or have you ever been entirely free from this disease since you first began taking treatment?
6. State as accurately as you can what has been the course of the disease and what treatment you have carried out since leaving the Mayo Clinic.

As a result 26 cases were heard from and out of this number a definite history of animal to man infection was obtained in 15 cases or 57 per cent of this number had treated cattle for lumpy jaw prior to onset of their infection, while 2 had treated horses for suppurating wounds about head and neck of animal. Of the remaining 11 cases in which no history of exposure was obtainable, each and every one admitted a fondness for chewing grasses and straw and habitually picking the teeth with same. Each case also gave a history of dental caries and pyorrhœa to some degree. While this series of cases is not large it seems to emphasize the point that transmission of this disease from lower animals to man is more frequent than infection direct from grain and grasses; at any rate it is far more frequent than we had at first believed it to be.

The results of clinical and experimental study early brought out the fact that the organism of actinomycosis required a twofold condition in order for infection to take place. First, the organism must by some means be conveyed to one of the portals of entry of the human body. Second, in order for infection to take place an abrasion of some sort in the tissues is necessary. Johne and others fed cattle on virulent cultures and yet did not succeed in producing the disease. It was likewise noted clinically that cases of infection about the jaws and oral cavity never gave rise to infection in the gastro-intestinal tract. A clue to the necessity of an abrasion in order for infection to take place was given by the frequency with which infection took place following feeding of rye or barley to cattle, the beards of the grain frequently piercing the mucous membrane and producing the necessary abrasion. Israel and others frequently traced cervicofacial actinomycosis to carious teeth, which were always on the same side on which

infection took place. The rare cases of infection of skin and superficial parts of the body as a rule followed wounds or abrasions of some sort. The frequency with which infection follows lodgment of foreign bodies either in gastro-intestinal or respiratory tracts which pierce or cause abrasions of the viscera, all tend to establish without a doubt the necessity of an abrasion of some sort before infection can take place.

PORTAL OF ENTRY

By far the most common portal of entry is the oral cavity; next in frequency the gastro-intestinal tract; third, respiratory; fourth, through abrasions on skin.

In the oral cavity the most common site for infection to take place is about a carious tooth or where there is a pyorrhœal tendency. In a large percentage of this series of cases a previous history of dental difficulty was given. The trouble often begins with a toothache which patient cannot localize definitely to any one tooth. He often gives a history of having had several teeth extracted in an effort to relieve the pain. Subsequently there is swelling in the cervical region or jaw of affected side. One of the cases here reported began as a unilateral sore throat and subsequently developed a peritonsillar abscess on this side, which was lanced and proved to be actinomycotic. Two other cases developed on buccal mucous membrane, opposite a sharp carious tooth which had caused an abrasion in this region. One man was an inveterate tobacco chewer and said he always kept a cud of tobacco on this side of his mouth and frequently bit inner surface of cheek so it bled. Invasion from lower jaw and into cervical region is more frequent probably because the lower teeth are more frequently carious.

Infection is rare in the superior maxilla. Only one case in this series and one was reported in literature. Our case, began in the left upper second and third molars. He had had both teeth extracted. The swelling appeared in the left temporal region a few weeks later. It was incised and drained three times. Then it spread to the supra-orbital region and again drained. Backward extension took place through the orbit and in a few weeks patient developed meningeal symptoms and died.

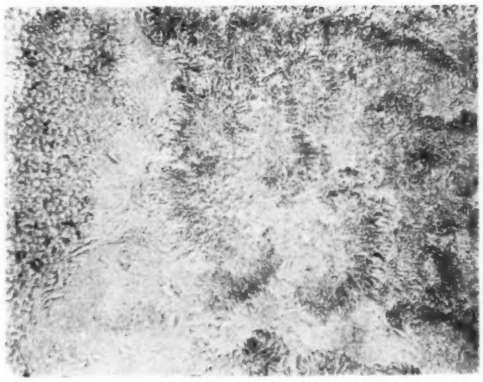

Fig. 1. Photomicrograph of actinomycosis smear showing radiate arrangement of clubs.

In the intestinal tract, there are two modes of invasion. One, which is very rare, is the generalized infection of the entire mucous membrane of intestinal tract. The fungus-filling glands of Lieberkuehn with a white coating over the entire surface of the mucous membrane consisting of mycelium of the fungus was first described by Israel. Only one case is reported in literature to date, that of Chiari. The other mode of invasion, which is quite common, is through the appendix. In the region of the appendix there is a stagnation of the fæcal current—favoring the lodgment of foreign bodies and the production site of small ulcerative areas. Perforation of swallowed foreign body may cause actinomycotic infection anywhere in gastro-intestinal tract.

In the respiratory tract there are also two modes of invasion: One through a catarrhal affection analogous to a bronchitis which is very rare, only one case being reported in the literature and one case in this series; the other and more common mode of invasion through a destructive disease of the pulmonary parenchyma itself. If no pleuritic adhesions form the disease may run a course similar to ordinary tuberculosis. However, if pleura once becomes involved, there is rapid spread by continuity to the chest wall. The most frequent mode of infection is

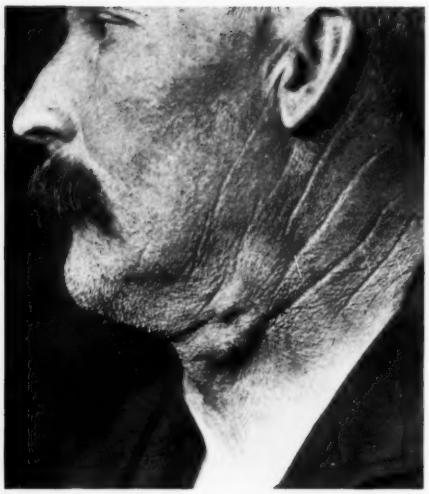

Fig. 2. Cervical actinomycosis with discharging sinus and linear puckering.

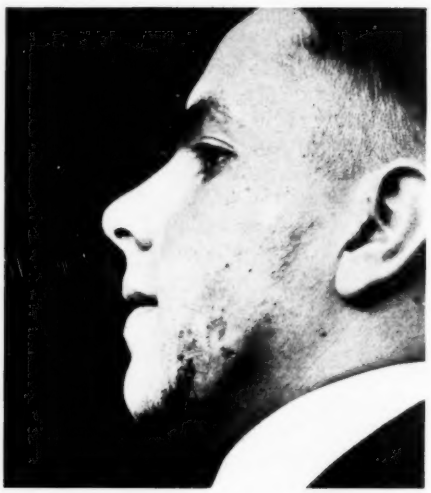

Fig. 3. Actinomycosis of jaw with multiple discharging sinuses.

through dust inhalation by men who follow grain threshing. The disease may also follow infection from an aspirated tooth or other foreign body—or by direct extension from neighboring organs.

Skin infection is rare and only through abrasion of skin does it take place.

PATHOLOGICAL FEATURES

While this organism shows its best growth in connective tissue and shows a predilection for connective tissue in its spread through the system, my findings do not agree with some authors in its being wholly limited in its growth to connective tissue alone. Cope does not believe extension to the peritoneum ever takes place. In one case in this series which came to autopsy the original site of infection was the appendix, and this patient showed multiple invasion of the peritoneal surface of the small bowel as well as extension to the liver, lungs, spleen and kidneys (Fig. 6).

It is practically certain that lymphatic metastases do not take place and this is a point in the differential diagnosis between tuberculosis and malignancy. There are cases recorded in the literature of pyæmic actinomycosis. George Dean reports such a case with actinomycotic endocarditis. Ponfick, in 1882, records two cases, also one of Israel's first cases was of pyæmic nature. These were all due to rupture of an abscess into a large vessel—a very rare occurrence. Otherwise extension of the disease occurs by continuity only. No tissue is immune to infiltration by it in its spread. Occasionally in the cervical region it may travel for considerable distance under skin and leave no signs of the disease in its wake. It invades bone either as a peripheral rarefying process, which is rare, or a central perforating type, which is more common in man. In liver, lungs, and spleen, it forms tubercle-like masses which coalesce to form larger degenerative areas which eventually break down in center. In subcutaneous tissues and fasciæ, it forms the typical hard, brawny, indurated growth which slowly undergoes a softening in the center as granulation tissue degenerates, and if not incised will in time break through the skin leaving a discharging sinus with a dusky, bluish discoloration around its margins. A characteristic of the larger sinuses is their tendency to granulation-tissue overgrowth at margins giving them a pouting appearance. This is often very marked in appendiceal forms, as shown in one of the cases in this series. Ulceration

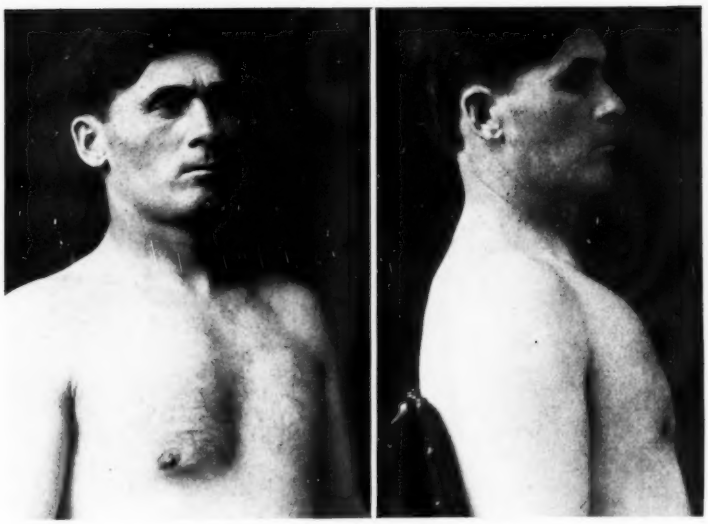

Fig. 4. Actinomycosis of lung with pleural and chest wall involvement as shown by bulging of right chest wall.

is seldom seen unless surgery has been attempted. Secondary infection always takes place as soon as opened up, which renders diagnosis very difficult. The discharge is seropurulent and contains the typical millet-seed bodies known as sulphur bodies. These are not always present unless the mass has reached a stage of softening. When cut into early, there is often nothing but a small amount of serum and a hard indurated mass of granulations obtained, instead of the expected pus. This frequently has led to erroneous diagnoses of malignancy in these cases. The sulphur body contains the fungus as a central mass of mycelium surrounded by the characteristic, ramate, clubbed bodies of the organism. It should always be looked for grossly in pus where disease is suspected.

CLINICAL COURSE AND SYMPTOMOLOGY

In the cervical and jaw cases there will frequently be a previous history of toothache with subsequent extraction of one or more teeth. On examining the oral cavity dental caries or pyorrhœa are found: a painless swelling in the region of the jaw or the neck develops. The swelling is usually circumscribed and is often mistaken for an enlarged gland. If not incised it usually breaks through the skin in time and discharges the typical seropurulent pus with sulphur bodies. If untreated other sinuses form and infection continues to spread into the subcutaneous tissue. A constant symptom in jaw cases is trismus. Likewise in appendiceal cases psoas spasm develops as soon as the infection burrows posteriorly involving the psoas muscle. The patient is never able to straighten his leg completely but keeps the thigh flexed on the abdomen to about ten or fifteen degrees. An erroneous diagnosis of tuberculosis of psoas muscle is often made on this account as in one of cases reported here. Appendiceal actinomycosis differs in no way from simple appendicitis. It may be acute, subacute, or chronic. The surgeon operates and removes the appendix and does not recognize the nature of the infection. In from 2 to 4 weeks an abscess may form either in the incision or at a point elsewhere. The incision is the most common site. The surgeon treats the abscess as a late wound infection and when the sinus persists, he suspects that a sponge has been left in the peritoneal cavity and frequently explores and finds nothing but an inflammatory mass

Fig. 5. Appendiceal actinomycosis showing typical pouting sinus in old McBurney incision. Front and side views.

at appendix site. This progresses until finally the entire right lower quadrant is filled with an inflammatory mass and a diagnosis of sarcoma is frequently made.

The pulmonary form of actinomycosis is very similar to active tuberculosis, lung abscess, or, if superficial, a catarrhal type of affection, a simple chronic bronchitis. Diagnosis is made by careful and painstaking repeated examinations of the sputum and a roentgenological study of the chest.

DIFFERENTIAL DIAGNOSIS

In the cervical region the disease is most often confused with tuberculosis, a diagnosis of suppurating tuberculous cervical adenitis frequently being made. The chief difference is the fact that this disease does not primarily involve the lymphatics and so soon as the incision is made and no suppurating or necrotic gland is found, the surgeon should be on his guard for actinomycosis. In this series of surgical cases two were found to be cases of actinomycosis which 10 years previously had been operated upon at the clinic and tissue diagnosed sarcomatous. It was only by chance in making a routine examination of the old slides for another condition that Dr. Broders found the fungus.

In the lung, actinomycosis is also often erroneously diagnosed as tuberculosis. A point of difference clinically is that actinomycosis does not begin at the apex. Careful sputum examination will as a rule show fungus in the sputum.

In the appendiceal region the disease is frequently diagnosed retroperitoneal sarcoma after tumor formation takes place. The previous history and associated sinus should put one on his guard for this disease. Likewise cases developing psoas spasm will not be diagnosed tuberculosis of the hip if this disease is kept in mind and the discharging sinuses investigated for the fungus.

PROGNOSIS

In neck and jaw cases, the prognosis is good. Of the 14 cervical and 7 jaw cases in this series, 12 reported themselves as entirely cured, 7 were improving but not entirely well. Skin cases, while stubborn, eventually clear up under vigorous treatment. The mortality in appendiceal cases was 100 per cent, all having died after being under treatment for 6 months to a year. The pulmonary form in this series was just as fatal as the appendiceal aside from the rare case of bronchial infection which was still living 20 years after infection took place, though patient was much annoyed by a chronic purulent bronchitis.

TREATMENT

This seems to be one disease in which potassium iodide is specific. Heroic doses, however, are necessary as even moderate doses do not produce results. The initial dose should not be less than 75 drops of the saturated solution, thrice daily, well diluted. This may be increased one drop daily until a maximum of 125 or 150 drops, three times daily, is reached. If symptoms of iodism intervene stop the drug for 3 or 4 days and then resume at the same dosage taken when

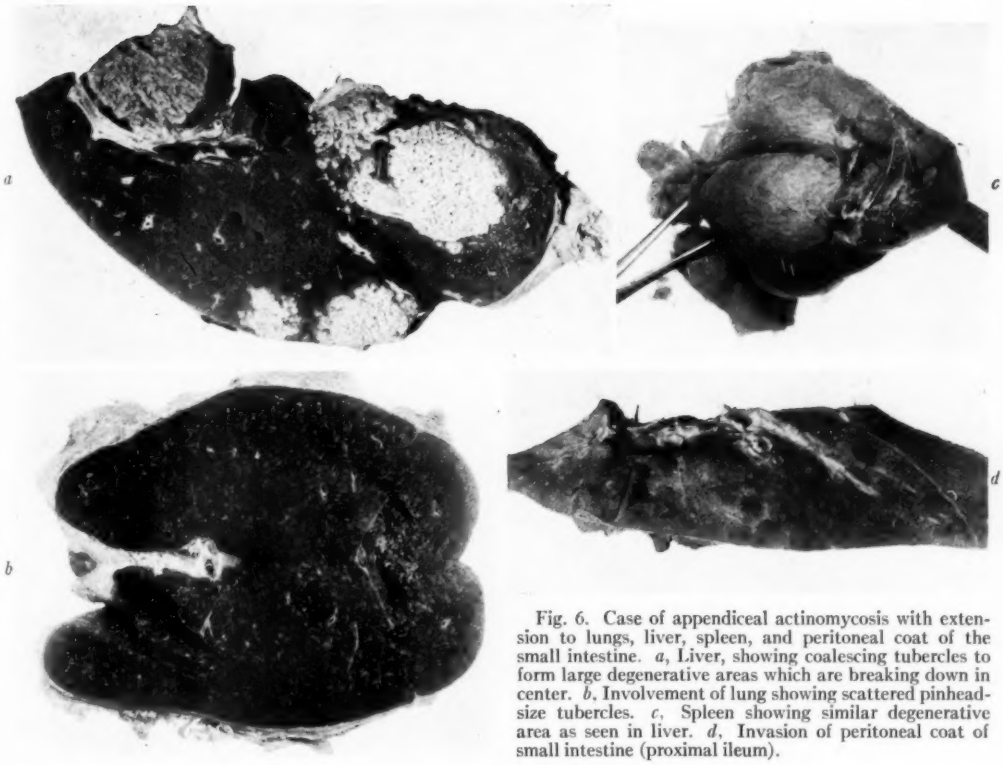

Fig. 6. Case of appendiceal actinomycosis with extension to lungs, liver, spleen, and peritoneal coat of the small intestine. *a*, Liver, showing coalescing tubercles to form large degenerative areas which are breaking down in center. *b*, Involvement of lung showing scattered pinhead-size tubercles. *c*, Spleen showing similar degenerative area as seen in liver. *d*, Invasion of peritoneal coat of small intestine (proximal ileum).

the drug was discontinued. By this method cases have taken as high as 150 drops three times a day eventually with excellent results and no untoward symptoms.

Surgery is of value only where the tissue involved can be widely excised. It was found of value in jaw and neck cases chiefly. The involved tissue was widely excised and the wound packed with iodinized gauze and kept open, with the hope of combating the anaerobic tendency of the parasite. While the surgical treatment no doubt hastened the cure in most cases, I do not believe it essential except where softening and abscess formation has taken place. The hard, inflammatory nodules before the stage of softening has been reached respond very well to potassium iodide alone as a rule.

A few of the cases were given $^1/_5$ grain copper sulphate, three times a day, internally, in addition to the iodide of potash. There was no noticeable increase in efficiency of the internal medication by this method and the cases given potassium iodide alone did fully as well. Local injections of pure carbolic acid has been reported of value in the literature but were not tried in this series of cases.

Radium and X-ray have been widely advocated as of value therapeutically. In our experience they were of value only as adjuncts to the surgical and medical treatment. Radium hastens the softening of the actinomycotic tissues in cases where the stage of softening has not yet been reached but it does not alone eradicate the parasite. Pulmonary and appendiceal cases were treated with radium and X-ray in addition to the internal administration of potassium iodide. While it was possible to arrest the disease to a certain extent the cases all proved fatal eventually.

Vaccines have been reported as of value but were not tried in this series of cases.

Space will not permit my reporting here in detail each of the cases included in this statistical study. Since leaving the Mayo Clinic, however, it has been my good fortune to have treated four more rather interesting cases of this supposedly rare disease. These cases are of special interest in view of the fact that three out of the four had previously been incorrectly diagnosed and were being treated for another condition, which is often the case in this disease.

CASE 1. R. H., single, age 26; marine fireman. Family history reveals no tuberculosis or malignancy. Past history is negative aside from an occasional winter "cold." In March, 1918, an abscess of the neck was drained. In July, 1918, the submaxillary glands of the right side of the neck were dissected. Patient's chief complaint is discharging sinus of neck. In January about a year ago, patient first noticed a lump under right jaw. Four months previous to this he had had ulcerated teeth which ached almost constantly. He had four extracted, but the pain continued and 4 months after this a hard nodule developed below the angle of the right jaw. Trismus was never present. The nodule gradually softened, broke, and discharged. Patient saw a physician who incised the abscess and said it was possibly a tuberculous gland. The sinus persisted and patient saw another physician who diagnosed the disease tuberculous, cervical adenitis and did a submaxillary dissection of right cervical glands. The wound never healed completely and in 2 weeks it broke down and a sinus again formed and discharged. The sinus has continued constantly until the present time, with recurring nodules which have been lanced six times since the submaxillary dissection was done. No subjective symptoms are now present aside from the discharge.

Examination of patient showed a well-nourished adult male who seemed normal physically aside from the following findings. Both bicuspids and the anterior two molars were missing in the right lower jaw. The rest of the teeth were in fair repair. There was an indurated area on the right side of the neck, bluish-red in color, the size of a pecan, and with a discharging sinus in the middle. An old scar from a previous operation was seen just above.

A small curette was inserted in the sinus and typical "sulphur bodies" in serosanguinous pus flowed from the sinus. Microscopic examination showed a typical ray fungus.

Under local anæsthesia the indurated nodule was freely excised and the wound packed with iodinized gauze. Patient was given 75 drops of saturated solution of potassium iodide three times a day, the dosage being increased 1 drop daily until a maximum of 110 drops thrice daily was reached. By this time the wound had completely healed and to date he has remained entirely well.

I was at a loss to account for the source of the infection in view of the fact that patient's occupation was marine fireman. However, on further questioning he informed me that he had been in the habit of going to the harvest fields of eastern Washington every year for summer employment. He said he frequently chewed the raw grain while at work in the fields as he was very fond of it.

CASE 2. M. N. K., married, age 56; farmers' store manager. Mother died of epithelioma of cheek. No family history of tuberculosis. In 1908, patient had appendectomy. He treated cow for lumpy jaw 20 years ago. One year ago he had an ulcerated tooth extracted. He was very fond of raw grain and chewed it frequently while in his store. He complained of a cough.

The cough began in July, 1919, and was dry, hacking, and became progressively more pronounced. He now coughs almost constantly and at times the paroxysms are quite severe. The appetite has failed recently, he has lost 16 pounds. The sputum became blood-streaked after the first month. In past few days patient has spit up rather firm nodular masses.

Examination showed a sick looking and rather dyspœnic man with a harrassing cough. Temperature 100.2°, pulse 90. Physical examination showed signs of consolidation in the right middle lobe. Except for loss of weight there is no other physical signs.

Roentgenogram of the chest showed condensation of the middle lobe of the right lung. A tentative diagnosis of a typical tuberculosis of the lung had been made. Sputum on examination had been reported negative for tuberculosis. Later sputum was examined again and showed the presence of the typical ray fungus.

Patient was given the usual dosage of potassium iodide together with massive dosages of radium and X-ray, but in spite of this fact he gradually lost ground and died within 6 months from the time of onset. He developed bone metastases before death.

CASE 3. J. D., single, age 27; hostler at Remount Station, Camp Grant, Illinois. Family and past history was negative. Patient complained chiefly of swelling and stiffness of the jaw. The difficulty began about 6 weeks ago, with toothache. Patient had been employed as a hostler since his army service began 6 months ago. As far as he knows he has not come in contact with horses having chronic ulcers or tumors about the head or neck. He said he was frequently in the habit of chewing raw grain and picking his teeth with blades of grass and straw. He had had two left lower molars extracted just before the onset of his present trouble. The swelling and stiffness of the jaw developed 1 week later. The swelling was lanced but no pus was found. Poultices have been applied constantly for the past 3 or 4 days. The pain is constant and moderately severe.

Examination showed a well-developed negro who was physically normal except for the following findings. There was a hard, brawny swelling at the angle of the left lower jaw. Trismus was such that he could open the jaw only to admit lead pencil between the teeth. Slight fluctuation seemed to be present deep in the tissues. A probe was inserted in the old incision which caused a free flow of seropurulent material containing typical sulphur bodies. Patient was also given large doses of potassium iodide. He left my care before complete cure took place, so I am unable to report end-result.

CASE 4. W. M., married, age 29; horseshoer. Family history negative. Past history negative aside from occasional attack of grippe. I saw this case postoperatively at the Army Hospital at Fort Riley, Kansas. Following a typical attack of acute appendicitis he had had appendectomy done December 1, 1917. A second operation for exploration of a sinus in the wound was done February 4, 1918. A third operation for exploration and drainage was done April 2, 1918. I saw him in May of this same year at which time he had a fixed, firm, irregular mass completely filling the right lower quadrant and extending up to the level of the umbilicus. There was marked psoas spasm on the right. The right leg could not be straightened beyond an angle of 170 degrees. I obtained the following report from his army record:

"Convalescence following appendectomy had been uneventful until 3 weeks following the operation when a hard mass formed at the lower angle of the wound. Hot fomentations were applied but it did not soften until 2 weeks later, at which time it was lanced and pus evacuated. Surgeon diagnosed it, stitch abscess. The wound kept draining, however, and on February 4, an exploration was performed for possible lost sponge. Nothing was found, except an abundance of adhesions and an indurated scar tissue at old appendix site. An iodoform gauze pack was inserted and the belly closed. Drainage continued and on April 2, a third operation was performed, at which time the sinus tract was excised. Since this last operation, a hard mass has gradually developed which at present fills the entire lower quadrant. Two discharging sinuses were present near McBurney's point. Six weeks ago there developed stiffness of the right hip which has remained in a constant state of partial flexion on abdomen. Patient is gradually losing weight and strength."

At this time a diagnosis of possible retroperitoneal sarcoma had been made by the surgeon. Examination of the discharge from the sinuses showed ray fungus infection to be present. I was interested in seeing the appendix which had been removed in this case and found upon exploring the tip a concretion the size of a small pea. On section of this concretion a piece of wheat grain was found in its center, proving without a doubt that this man had been infected directly through swallowing raw grain.

I was transferred to another post before treatment could be instituted so cannot give end-result.

CONCLUSIONS

1. There is but one true species of micro-organism capable of producing actinomycosis in man and lower animals and this is the one isolated by Wolff and Israel and later more fully described by Wright.

2. There is no convincing clinical evidence supporting the theory that this organism is a normal inhabitant of the oral cavity and gastro-intestinal tract of man.

3. There is much clinical and biological evidence that this micro-organism has its source outside of the human body and is capable of a dual existence: first as a saprophyte in old sod soil from which it gains access to grains and grasses and through this medium or intermediary host so to speak, it becomes capable of infecting man and lower animals.

4. In order for infection to take place two things are necessary: first, an abrasion of the tissues: second, the fungus must in some way be brought directly in contact with this abrasion.

5. Animal-to-man infection is far more common than we have been led to believe it was by earlier investigators.

6. Human actinomycosis is not a rare disease, but a disease which is often overlooked or incorrectly diagnosed.

7. Every inflammatory swelling of chronic or subacute nature with persistent and recurring sinus formation should be carefully investigated for this disease.

8. A negative smear, on first examination, does not rule out infection as the fungus, in the presence of mixed infection, is often very difficult to find.

9. The disease should always be kept in mind in every case of atypical pulmonary tuberculosis and should be looked for in cases suffering with chronic purulent bronchitis or bronchiectasis.

10. Early treatment of superficial lesions are highly successful. Internal infections are extremely fatal and hopeless.

I desire to express my thanks and appreciation to the Mayo Clinic for having had the opportunity of conducting this study, and for the help rendered by the statistical department of this institution.

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THE MANAGEMENT OF ACUTE CRANIAL INJURIES BY THE EARLY, EXACT DETERMINATION OF INTRACRANIAL PRESSURE, AND ITS RELIEF BY LUMBAR DRAINAGE[1]

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SURGERY is gradually overcoming obstacles to its employment in the various regions of the body as the advances in our knowledge of anatomy, physiology, and pathogenesis make the conditions for operation more clear. Thus history has shown how, in turn, the abdomen, the chest, the joints, and the head have been successfully invaded. The realm of *acute injuries* of the head, however, has been neglected by the surgeon. Advances in our knowledge of physiology and pathogenesis of acute brain lesions have not been utilized and procedures of diagnosis and treatment are today in a stage comparable to those employed for abdominal lesions of 30 years ago.

In this paper I shall endeavor to prove the following points regarding acute traumatic injuries of the brain.

Pathogenesis. The all important finding is that of *increased intracranial tension* due to œdema and hæmorrhage of the brain, causing interference with the paths of absorption of the cerebrospinal fluid. If not relieved early, the increased pressure leads to chronic morbid changes in the cortex of the brain, or in extreme cases, to death.

Symptoms. The symptoms usually depended on for indications to surgical interference, such as slow pulse, high blood pressure and stertorous respiration, are *late* symptoms and are due to *medullary* pressure. Surgery is of little avail if one waits until the medulla is involved.

Diagnosis. The early diagnosis of increased intracranial tension can be easily and directly made by estimating the pressure of the cerebrospinal fluid by the mercury manometer connected with the hollow needle inserted as for lumbar puncture. This increased pressure antedates the appearance of the secondary symptoms of medullary pressure by many hours.

Treatment. The relief of intracranial pressure can be obtained early and safely by repeated lumbar drainage. The relief so obtained prevents medullary compression and the symptoms usually looked upon as indications for operation do not appear.

Subtemporal decompression (supratentorial) does not adequately relieve pressure on the medulla (subtentorial), but lumbar drainage does relieve pressure on the medulla and suffices to prevent death; when the concomitant hæmorrhage and œdema of the brain has time to subside, the normal circulation of the cerebrospinal fluid is re-established.

Realizing that the dicta cited above are somewhat revolutionary and are not in accord with present-day usage, I shall present evidence from a clinical study of one hundred cases of acute cranial injury and experimental evidence upon dogs in an attempt to establish their correctness. (The experimental work

[1] A report of experimental work done in the Department of Surgery, Northwestern University Medical School and Cook County Hospital in conjunction with Prof. F. C. Becht of the Department of Pharmacology, Northwestern University Medical School.
Read before the Chicago Surgical Society, April, 1921

was done at Northwestern University in conjunction with Professor F. C. Becht).

HISTORICAL

Our data of the anatomy and physiology of the cerebrospinal fluid system are of comparatively recent acquisition and considerable yet remains to be discovered.

Eighty years ago, Majendie (1) discovered, in the roof of the fourth ventricle, the minute opening that bears his name and pointed out the connection between the cerebrospinal fluid in the ventricular system and that in the subarachnoid spaces of the brain and cord. By this epochal discovery he led the way to a correct understanding of the circulation of the cerebrospinal fluid and to problems associated with increased intracranial tension. Thirty-five years ago Corning (3), an American, tapped, for the first time, this cerebrospinal water-bed by inserting a needle between the last two spinous processes of the dorsal vertebræ, for the purpose of anæsthetizing the cord. Thirty years ago Wynter (4) drained the spinal system for tuberculous meningitis. It is to Quincke (5), however, that we owe our greatest knowledge of lumbar puncture and intracranial tension. In 1891 he published his studies on the diagnostic and therapeutic application of lumbar puncture and his work stands, after 30 years, as a perfect elucidation of the pathogenesis of lesions that affect the cerebrospinal fluid system. Quincke made it a rule always to *measure the pressure* of the cerebrospinal fluid by connecting the lumbar puncture needle with a fine glass pipette in which the fluid was allowed to rise. He found the normal pressure to be between 90 and 120 millimeters of water. Recently Weed (2) has shown how the cerebrospinal fluid finds its way from the foramina of Majendie and Luschka, through the subarachnoid spaces over the cortex of the brain to be absorbed mainly by the arachnoidal villi along the sinuses, especially the longitudinal sinus. I have found that any swelling or œdema of the cortex of the brain due to injury arrests the circulation of the cerebrospinal fluid and raises intracranial tension, ultimately endangering the medulla and floor of the fourth ventricle. Since Quincke's time a great amount of work has been done upon the acute and chronic forms of increased intracranial tension—such as occurs in hydrocephalus, brain tumors, uræmia, alcoholism, and the acute and chronic forms of meningitis. But the field of *acute traumatic injuries* has been neglected by the surgeon. In 90 per cent of the cases of acute cranial injuries—where there is subdural hæmorrhage or œdema—the patients are now treated expectantly by ice cap, catharsis, morphine, etc. Nothing accurately is determined as to intracranial pressure during their stay in the hospital or after leaving. Should they develop the late symptoms of medullary compression they are operated upon but too late for any hope of a successful outcome.

This state of affairs is partly to be explained by the work of Cushing (6) and others whose experiments seem to prove that the general blood pressure is an accurate index to intracranial tension. Following their line of thought, cases of brain injury are treated expectantly in practically all hospitals and no operative interference is called for until the general blood pressure reaches 170 or more and the pulse becomes slowed to 60 or less. No effort is made to determine the intracranial pressure by *direct* estimations, partly because the pulse, eye-ground and general blood-pressure findings are relied upon and partly because it is considered dangerous to perform lumbar puncture. I shall show by cases of my own and from reports of others that both these dicta are not to be relied upon for acute cranial injuries; that general blood pressure is low for many hours, due to shock, and that its rise is so slow in the cases that might be saved by operative interference that when it does occur, it is too late a finding to be of service. The danger of lumbar puncture in these acute traumatic cases has been greatly overestimated. Practically all of the sudden deaths following lumbar drainage have been in cases of chronic tension due to tumors, especially those below the tentorium cerebelli.

The technique of the exact determination of intracranial tension by the manometer has never been standardized. There has been

a lack of uniformity in reading results and in type of instrument used. Therefore, the procedure had fallen into disuse until Landon (7), sometime assistant to Frazier, in 1917, described a method of accurately determining the intracranial tension by a mercurial manometer and drew the attention of the profession to its importance in both medical and surgical conditions. He did not publish his results, however, by series of cases and little more was heard of the procedure until Sharpe (8) published his work last year on *Acute Brain Injuries*. Sharpe for the past 3 years following Landon's technique has based his indications for operation on the state of the intracranial tension as determined by lumbar puncture manometric readings, and by the examination of the eye-grounds. If the tension rises above 16 millimeters of mercury and the eye-grounds show beginning œdema, he performs a subtemporal decompression. He records results of a large series of cases.

Since my return from the Army I have been estimating the intracranial pressure in all my cases at the County Hospital and in private practice and present my results of a series of upward of 100 cases herewith.

Up to the present time the status of our management of acute cranial injuries is well outlined by Besley (9), who, in 1916, analyzed 1000 cases of fracture of the skull. He states that:

> The signs of general intracranial pressure produced by bleeding or œdema are usually present as manifested by unconsciousness, slow pulse, embarrassed respiration, high blood pressure, choked disc and vomiting. The advisability of making a lumbar puncture in all cases of suspected skull fracture comes into question. When blood is found in the cerebrospinal fluid it is highly presumptive evidence of the existence of a fracture. The procedure is by no means free from danger, especially in those cases in which there is a marked increased intracranial pressure. The danger is that, with the relief of pressure within the spinal canal, the medulla and pons may be forced into the foramen magnum and constricted sufficiently to cause immediate death. Therefore, it is not our routine practice to do spinal puncture in all cases. It is not done if the diagnosis can be made certain from other signs and symptoms. This procedure is reserved for that class of cases in which a patient is picked up on the street in coma and remains unconscious with no obtainable history of injury. If a positive diagnosis is not arrived at from other evidence a spinal puncture is done.

He then goes on to state: "It is surprising how infrequently the pulse rate is slow. The average is 96 in all cases, in only 65 of 1000 cases was the average below 70."

Furthermore, the respiration fails to show a striking characteristic change. There is vomiting in only 36 per cent. Vaughan, (10) moreover, has shown how little reliance can be placed on eye-ground changes in traumatic cases. Papillœdema is a late finding in intracranial tension. I have never been able to show an increase in general blood pressure early in these cases. In fact the patients are in shock for many hours after their accidents, with a rapid pulse and lowered blood pressure.

Rawling (11) in a study of cerebral œdema during the war states that blood pressure is affected but little. William Sharpe states that "the high intracranial pressure necessary to raise the general blood pressure to any appreciable extent must reach a very dangerous state of compression in these acute cases before its effects can be observed in an increased blood pressure. I feel, therefore, that the blood pressure as an important aid in the treatment of brain injuries has been much over emphasized." I might add that similar objections can be brought against the other symptoms and signs of acute intracranial tension. If, therefore, the symptoms and signs of increased intracranial tension, as increased blood pressure, slow pulse, vomiting, eye-ground changes of papillœdema, sterterous respiration, etc. are *delayed* evidences of intracranial tension that come on slowly and *indirectly* by pressure on the medulla, and are influenced by other factors such as shock and hæmorrhage and result often in blindness or death, is it not better to estimate the pressure early and directly before these dangerous symptoms arise? Especially so if the procedure is not fraught with danger. Granting, for the moment, that it would be dangerous to withdraw fluid in very high intracranial pressure, it is possible by a simple apparatus to estimate this pressure without the loss of a single drop of fluid by directly attaching the manometer to the

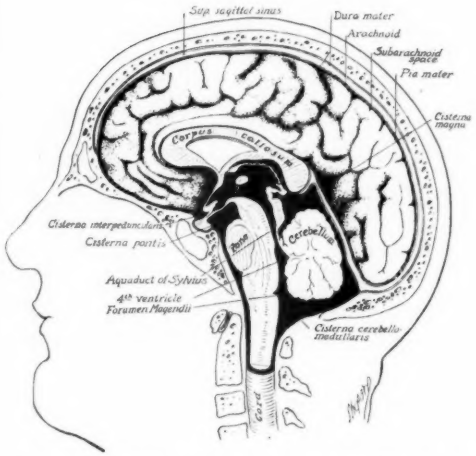


Fig. 1. The subarachnoid spaces in a median section of the head. Note the dilated basal cisterna and their free connection with the spinal subarachnoid space.

spinal needle. Kroenig (12) states that if the fluid pulsates it is in direct connection with the brain and fluid can be withdrawn without danger. If the pressure is high that is all we need to know. It may be from hæmorrhage or œdema; the indications are the same: Relieve this pressure by lumbar drainage and prevent papillœdema and pressure on the medulla. I do not agree, however, that the procedure is dangerous in the acute traumatic cases. This is an error that has crept into our calculations from results with cases of chronic tension, especially in tumor cases of the base of the brain.

Schoenbeck (13) in a recent review of deaths following lumbar drainage collected 71 cases and in 67 found by autopsy there was tumor or other chronic disease of the brain. Gumprecht (14) in 1900 collected 17 cases of sudden death following lumbar drainage, and autopsy showed them to be caused by pressure of tumor. Many of these were punctured in the sitting position and 15 to 60 cubic centimeters of fluid was withdrawn at one time. The accidents are due to pressure on the medulla by the walls of the foramen magnum and hæmorrhage from the tumors because of sudden release of tension on their vessels. The latter accident can also occur in decompression operations

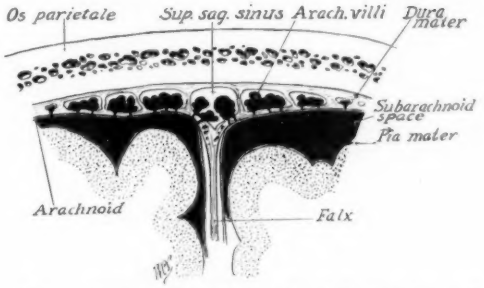


Fig. 2. Frontal section through the skull, meninges, and brain. Note the arachnoidal villi connecting the subarachnoid space with the dural sinus. (Modified from Key and Retzius.)

with sudden release of tension. On the other hand, I, or my assistants have done upward of 300 lumbar punctures in acute injuries to the head within the last year without untoward symptoms. Our patients are all in the horizontal position and usually not more than 10 to 20 cubic centimeters is slowly removed at one time.

Sharpe (15) has done 1100 lumbar punctures in the last 3 years with these precautions without a death. Kaliski (16) reports one death in over 10 years of this work and states that this could not be definitely attributed to the lumbar puncture. So I believe that we must take a different attitude toward these acute traumatic cases than we entertain toward the chronic cases where there is considerable molding of the brain by long-continued pressure.

In fact Kahler (17) is so impressed with this view that in a recent study he has tried to find some other factors responsible for deaths in cases of chronic cranial hypertension. His findings are that there is a rise of general blood pressure after lumbar puncture in cases of cerebral disease that may account for their sudden exitus. In those acute traumatic cases I have examined, the general blood pressure falls slightly immediately after lumbar puncture and would suggest lessened danger from that source. Kahler believes that estimation of the blood pressure, before and after lumbar puncture, is of considerable diagnostic significance in differentiating disease of the brain from other conditions, and can be used as a guide for the removal of fluid.

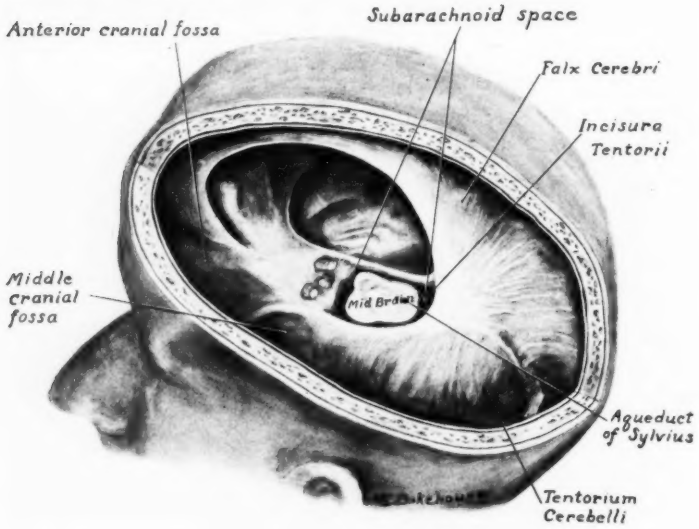


Fig. 3. Original drawing from a dissection of the skull at Northwestern University Medical School, showing the dural compartments above the level of the tentorium cerebelli. Note the isthmus of the tentorium cerebelli (incisura tentorii) and the narrow subarachnoidal space on either side of the mid-brain. This is the only connection between the subtentorial and supratentorial subarachnoid space. (Courtesy of Professor S. W. Ranson.)

ANATOMY AND PHYSIOLOGY

In order to understand the advantages that may be gained by lumbar puncture, it is necessary to have freshly in our minds the anatomy of the cerebrospinal water-bed. The cerebrospinal fluid is probably secreted in the ventricles by the choroid plexus. The lateral ventricles normally contain about 30 cubic centimeters. The fluid finds its way from the lateral ventricles through the foramina of Monro to the third ventricle, thence along the aqueduct of Sylvius to the fourth ventricle.

In the roof of the fourth ventricle posteriorly is the foramen of Majendie and in each lateral recess the foramen of Luschka through which the fluid escapes to the large cisterns beneath the arachnoid. These reservoirs have been named by Toldt according to their location. There are cisterns of the sylvian fissure, optic chiasm, interpeduncular space, pons, cerebellomedullary region and great vein of Galen. They contain normally about 60 cubic centimeters of fluid but in pathological states may contain two to three times this amount. Another 30 to 60 cubic centimeters is present in the spinal portion. The fluid rises through the incisura tentorii to be distributed over the cortex of the cerebrum. This is constantly being absorbed, mostly by the arachnoidal villi into the dural sinuses when there is no obstruction to its circulation. The total amount is renewed, as some believe, several times during the day, serving to dilute and carry off the metabolic waste products of the brain.

The cerebral and spinal subarachnoid systems are freely connected with each other, as was first demonstrated by Key and Retzius (18). This allows artificial drainage of the cerebral subarachnoid water-bed by the spinal route.

The circulation of the cerebrospinal system has always been rather vaguely described and surgeons generally have overlooked its importance. While some have realized the

importance of relieving the increased pressure of the cerebrospinal fluid, its metabolic function of carrying off waste matter has not been emphasized. The fluid after leaving the foramina of exit in the fourth ventricle finds its way upward from the basal cisterns through the narrow subarachnoid space of the incisura tentorii (Fig. 3) to the surface of the cerebrum, where it is absorbed for the most part into the dural sinuses and arachnoidal villi scattered over the surface of the brain. A slight swelling or hæmorrhage of the cerebrum or midbrain blocks the cerebral subarachnoid spaces and the fluid cannot be absorbed along its natural channels. The fluid no longer rises above the tentorium but collects in the basal cisterns and in the ventricles and stasis results. The enlargement of the basal cisterns forces the midbrain up and occludes further the narrow subarachnoid spaces in the incisura tentorii. The enlargement of the lateral ventricles above the tentorium forces the cortex of the brain still more against the dura and, unless the excess of fluid is withdrawn from below the tentorium, a dry and flattened cortex is found at autopsy. The medulla suffers from the direct pressure of the fluid in the basal cisterns which gives evidence by symptoms of vomiting, bradycardia, high blood pressure, and stertorous respiration.

Thus, we see a vicious circle set up—impeding the absorption of cerebrospinal fluid more and more until the resultant pressure rises so high that death results.

PATHOGENESIS

The tension of the cerebrospinal fluid may be increased in traumatic cases by a number of factors restricting the space usually occupied by cerebrospinal fluid:

1. Any depression of the skull, especially depressed skull fractures;
2. Hæmorrhage extradural—as in middle meningeal or sinus rupture;
3. Subdural hæmorrhage;
4. Subarachnoid hæmorrhage or œdema;
5. Subpial hæmorrhage or œdema;
6. Intracerebral, cerebellar, or spinal hæmorrhage or œdema;
7. Ventricular hæmorrhage;

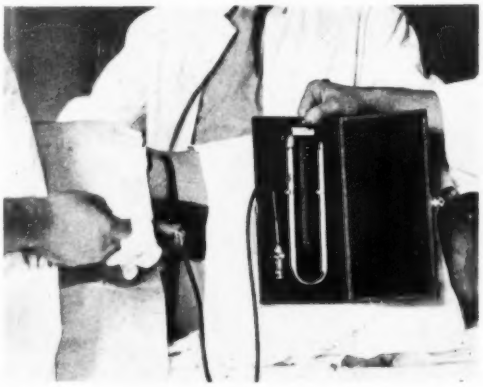
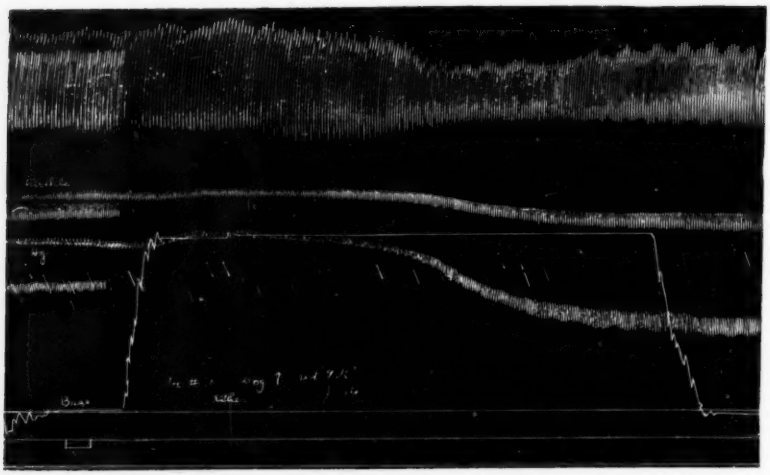


Fig. 4. Illustrating method of estimating intraspinal pressure with mercury manometer. Note the patient in horizontal position, needle in fourth lumbar interspace, and height of mercury column level with spine.

8. Increased secretion or decreased absorption of cerebrospinal fluid.

In depression of the skull and extradural hæmorrhages the pressure is usually localized and it is quite obvious that these conditions must be relieved locally by raising the depression and ligating the bleeding vessel. In the great majority of cases the other factors mentioned above come into play; the brain is pressed against the dura more or less, generally preventing the cerebrospinal fluid from reaching the arachnoidal villi to be absorbed. The secretion of fluid within the ventricles continues, however, so that within a short time, depending upon the extent of the cerebral œdema, the accumulation of fluid is so great at the base of the brain that the floor of the fourth ventricle and the medulla is endangered. The cerebral œdema sets up a vicious circle by cutting off the paths along which the cerebrospinal fluid is absorbed. This allows of a dilatation of the basal cisterns pushing up the mid-brain and blocking the isthmus of the tentorium cerebelli. This may explain the high pressures I have found after subtemporal decompression where the reading was taken by lumbar puncture. Le Count, in a review of the pathological lesions present after skull injury, found the brain pressed against the dura and the subarachnoid water-bed non-existent. The normal cisterns of the sulci were obliter-

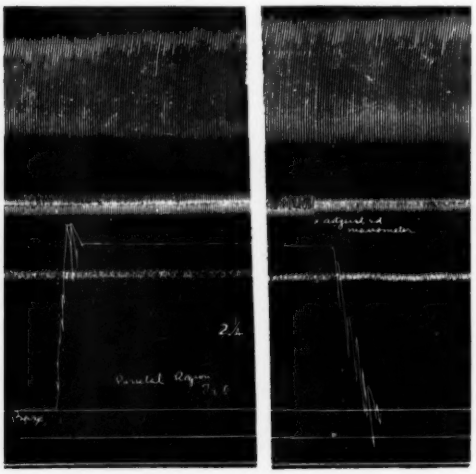


Graph 1. Intracranial pressure applied over medulla. Note primary stimulation of respiration, a slight rise in blood pressure, with the heart rate practically unaffected. Later, a decrease in respiration and fall in blood pressure and a marked slowing of the heart rate. Lastly, a return to normal when pressure is released.

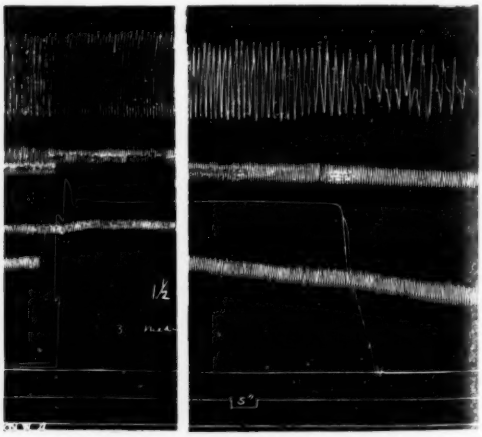
ated. Drainage above the tentorium is of little avail in these cases. It is my opinion that relief here can be obtained much better from below by lumbar puncture than by suboccipital or subtemporal decompression.

PATHOLOGY

Le Count (19) in an analysis of 547 cases of skull fracture that came to autopsy out of 908 cases collected from the records of the Cook County Hospital between 1911 and 1918 summarizes the chief pathological lesions as follows:



Graph 2. Pressure applied above the tentorium. There is no change in respiration, blood pressure or heart rate.



Graph 3. A repetition of the experiment shown in Graph 1 with identical results.

Twenty per cent are extradural hæmorrhages resulting from rupture of the middle meningeal artery—of these 63 per cent were not recognized clinically and of the 37 per cent recognized and operated on only 11 were saved, making the mortality of this condition 89 per cent.

In 95 per cent of all fractures there were subdural injuries. These consisted of subarachnoid or subpial hæmorrhages with a maximum of 100 grams of blood, the average being 40 grams and only 1 to 10 grams in 40 per cent of the cases. The subarachnoid hæmorrhage was due to bruises of the brain and rupture of the leptomeningeal vessels. The subpial hæmorrhage was from tears of subpial arteries. These were not so extensive as the subarachnoid hæmorrhages. It is quite evident that a considerable proportion of this blood can be removed by lumbar drainage.

The most frequent change in the brain found in persons dying from fracture of the skull was *traumatic œdema*. Here the convolutions were found flattened, suggesting *pressure of brain against dura and skull* and the *disappearance of the subarachnoid water-bed*. The cerebral vessels were empty and flattened suggesting an anæmia of the cortex. The peripheral ends of the sulci were closed—obliterating the normal cisterns of cerebrospinal fluid. The fluid in the leptomeninges was lessened and the visceral layer of the arachnoid almost dry when the dura was first removed. Then sweating occurred in the form of minute droplets on its surface.

Certain conclusions of great value from the standpoint of treatment may be drawn from these postmortem findings.

First, the almost constant finding of brain injury with hæmorrhage and œdema. This causes a swelling of the brain and restricts the size of the cerebrospinal spaces even to obliteration in severe cases. There can be no absorption of cerebrospinal fluid by the usual routes and with continued secretion of fluid within the ventricles there is added to the pressure created by blood clot and swollen brain that of unabsorbed cerebrospinal fluid in the basal cisterns. This increased pressure in the unexpandable cranial cavity is transmitted to the fluid in the spinal canal and can be measured by a mercury manometer attached to the lumbar puncture needle. We have in this way an accurate measure of pressure variation within the cerebrospinal system. For the actual destruction of brain tissue by trauma there is no remedy. We must, however, prevent any further destruction of the delicate brain cells by immediate relief of the pressure anæmia caused by the œdema and hæmorrhage.

Second. There is a simple method of relieving this increased pressure and of drawing off the effused blood. Through the direct connection of the spinal subarachnoid waterbed with the basal cisterns and ventricles, a needle inserted in the lumbar regions can relieve the pressure to any degree by measurement with the mercury manometer.

The only other logical method would be by suboccipital decompression—which is mutilating and unnecessary. Subtemporal decompression, as Cushing advises, does not afford relief to the medulla.

Third. The present classification of brain injuries into concussion, contusion, and compression is illogical. A better classification from the standpoint of surgical treatment should be based on *compression* alone; or better stated, increased intracranial tension, as there is very little of any true compression of the brain.

SYMPTOMS

The only sign of any value, early, is that of the cerebrospinal fluid tension as determined by the mercury manometer, and the presence of blood in the fluid. Confirmatory, would be the evidences of fracture by the X-ray. Paralyses indicate the localization of the lesion.

The symptoms usually relied upon—the slow pulse, embarrassed respiration, vomiting, and high blood pressure—are symptoms of medullary compression, endangering life and appearing too late for successful surgical interference. Papillœdema also appears late.

Quincke (20), in 1905, after many years of observation on the cerebrospinal fluid pressure, draws the following conclusions regarding symptoms:

"In acute brain injuries, the general symptoms often fail us. Moreover, in determining the *grade* of hypertension in acute injuries the general symptoms often fail us. It is in these cases that the *estimation of the cerebrospinal fluid pressure* is of most importance and the best results gotten by lumbar drainage. Acute serous meningitis, after concussion of the brain, often leads to chronic serous meningitis if not relieved. Chronic headaches, intolerance to alcohol, and neurasthenic symptoms often follow concussion with unrelieved hypertension."

It is only by the estimation of the pressure by the mercury manometer that one can make the diagnosis. We must realize that the slow pulse, embarrassed respiration, high blood pressure, choked disc, and vomiting are not the early signs and symptoms of increased intracranial pressure in the surgical sense, but are signs and symptoms of medullary compression, and it must be made very plain that once the medulla is endangered—the chances for life are very small indeed.

There is only one sure way of estimating increased intracranial tension before the medulla is affected by transmission of the pressure—and that is directly with the manometer. Who today waits for general signs or symptoms of increased blood pressure? Who still prides himself that he can estimate blood pressure by palpation of the radial artery? Who neglects today the use of the mercurial manometer in the exact estimation of blood pressure? Why, then, should our attitude toward cerebrospinal fluid pressure be any different? There are those who still count the drops per minute of the exuding spinal fluid or who measure the height with the eye to which the fluid spurts. The brain, unlike the heart or the abdominal contents, is a very delicate organ and withstands trauma but poorly. It is all the more important, therefore, that this organ be spared as much as possible long continued pressure. Watchful expectancy in cranial insult is criminal. The early and exact estimation of this deadly pressure and its early relief, if present to a harmful degree, should be our primal consideration. The surgical measures for this relief are at our hands and they should be executed in suitable cases as soon as possible. Theoretically, blood clot may so obstruct the cerebrospinal system that a spinal pressure reading may not be obtainable. I have never found this to be true in any of my cases; neither have I seen recurrence of cranial hæmorrhage after lumbar drainage.

DIAGNOSIS

Twenty per cent of the cases of head injury that come to autopsy present middle meningeal hæmorrhage which show an increasing pressure on the spinal water-bed with clear fluid—unless there is concomitant dural injury, in which case the fluid may be bloody. In subdural cases seen early, the diagnosis of brain injury—that is hæmorrhage and œdema — is made by repeated lumbar puncture—with the finding of blood, and an increased tension of the cerebrospinal fluid. The presence or absence of linear fracture is of secondary importance. The general symptoms of slow pulse, embarrassed respiration, increased blood pressure, papillœdema, and unconsciousness appear later if the increased tension is not relieved. They need not appear at all if tension is kept within normal limits by lumbar drainage. Focal symptoms help to localize the lesion of the brain.

PROGNOSIS

Variations in the manometric readings are the best guide to prognosis. Increasing pressures show that the lesion is progressing unfavorably. Decreasing pressures indicate a favorable outcome. Continued increased pressure indicates chronic hypertension, which, if not relieved, leads to symptoms usually classified as "traumatic neurosis," but are really evidences of a gliosis of the cortex.

TREATMENT

The expectant policy of most hospitals in acute brain injury has been superseded in my service at the Cook County Hospital by the following routine:

1. An examination of the head to determine site of injury and to rule out depressed fracture—first by inspection and direct palpation and later by X-ray.

2. Routine lumbar puncture. Take pulse and blood pressure before and after puncture. If blood is present in fluid and the pressure is high, withdraw 10 to 20 cubic centimeters

cerebrospinal fluid, determining the fall in pressure by special stopcock arrangement of needle attached to mercury manometer, and stop withdrawing fluid when pressure has been reduced one-half or to normal. If pressure reading is high and no blood is present in fluid, suspect middle meningeal hæmorrhage without rupture of dura.

Technique. Have patient on right or left side in *horizontal plane* and on an *unyielding* surface, with spine flexed—if necessary in a restless patient give a preliminary hypodermic of morphine or gas anæsthesia. Surgically cleanse area of fourth lumbar interspace and insert needle in mid-line. Withdraw stilet and as soon as cerebrospinal fluid appears, connect needle with mercury manometer held by assistant at level of spine and take reading. Then open side arm and collect cerebrospinal fluid in graduated sterile test tube. Shut off fluid when 10 to 20 cubic centimeters is collected or when pressure reaches normal, withdraw spinal needle and seal with collodion.

Description of instrument. The instrument is a simple U tube with side arm, made for me by Mueller & Company. Attached to the side arm is a rubber tube which connects readily with the lumen of the needle by a metal sleeve. The needle is 1 millimeter bore and has a horizontal stopcock which allows withdrawal of cerebrospinal fluid without disconnecting the manometer so that one can see the fall in mercury column while withdrawing fluid.

3. Treat shock, by usual methods.

4. Repeat lumbar puncture at intervals of 6 to 24 hours or longer, depending on height of pressure and rapidity with which pressure rises after withdrawal of fluid.

5. Other routine examination of the eye-grounds, reflexes, pulse, temperature, respiration, etc., to complete physical examination.

6. Keep patient in bed for 4 weeks in severe cases and take pressure reading before patient leaves the hospital to rule out any tendency to chronic hypertension.

In the non-fatal cases only those are tabulated where fairly complete records had been kept.

In all cases the blood pressure has been taken on successive days, both before and after lumbar puncture. It is usually between 100 and 150 systolic—low while the patient is in shock and slowly rising to what appears to be normal for the individual. In no cases of the series except one has it exceeded 170 systolic. In only 8 cases was it above 150. In 28 cases it was below 130. In those cases that showed a systolic pressure over 150, the patients entered after an interval or there was chronic hypertension due to systemic causes.

I have recorded the lowest pulse record on the accompanying charts. In 28 per cent of the cases, the pulse was below 60. In 50 per cent, the pulse was above 70. There seemed to be no slowing of the pulse or increase in blood pressure in those cases where the cerebrospinal fluid pressure is kept low by repeated lumbar drainage.

The eye-grounds were examined in most of the cases and in only three of the series was there papillœdema. The absence of papillœdema in most of the cases also was due to the repeated tappings of cerebrospinal fluid. The three that showed papillœdema were cases coming into the hospital several days after injury.

The cerebrospinal fluid pressure was above 30 millimeters mercury in 14 per cent, the highest reading being 60 millimeters. In 34 per cent, the pressure was between 20 and 30 millimeters. In 44 per cent, the pressure varied between 10 and 20 millimeters of mercury. In the fatal cases the pressure within the spinal canal varied between 12 and 60 millimeters. The mortality rate has been decreased from 50 to 25 per cent. A report on morbidity will be made after a sufficient interval has elapsed to be of value.

An analysis of our cases show that they fall into four general groups.

First, there are those cases of very severe crushing injuries of the head with medullary injury that succumb within a very few hours or at most 24 hours. With these very little can be done medically or surgically, and they constitute in this series of cases 13.3 per cent of the total number. The cerebrospinal fluid pressure varies between 12 millimeters and 60 millimeters of mercury.

ACUTE BRAIN INJURIES—SEVERE CASES

Case	Age	Injury produced by	Pulse	Symptoms	Blood pressure mm.	Cerebro-spinal fluid pressure mm.	Amount with-drawn c.cm.	Pressure after-ward mm.	Fluid	Result
J. A.	55	Automobile	60	Coma, 5 days		12	10	8	Bloody	Recovery
						10	5	6	Yellow	
A. C.	28	Automobile	68	Coma	118–72	12	10	7	Bloody	Recovery
			64			9	5	5		
S. D.	64	Fall over railing	124	Coma. Bleeding from		18	20	8	Bloody	
			80	nose		14	10	6		
						10	5	6		Recovery
F. H.	41	Fall from truck	44	Coma. Later vomiting	168–80	20	15	8	Bloody	
			56		after-ward,	14	10	6		Recovery
					130–80	9	5	6		
T. H.	52	Drunken brawl	60	Comatose. Lacerated	120–86	6	10	4	Bloody	Recovery
			70	scalp	112–78					
F.D.	54	Motorcycle	80	Comatose, for 1 week.	165–118	20	30	7	Bloody	
	1st day		100	Fracture, left parietal region	150–110	40	27	5	Bloody	
	4th d.		90	Headaches.						
	8th d.		80	Talks intelligently	148–112	30	30	6	Clear	
	11th d.		76	Rational, no headache	145–110	10	5	6	Clear	Recovery
J. I.	35	Fall down stairs	62	Coma. Bleeding from	120–75	17	10	10	Bloody	Improved
				right ear		12	10	6		
A. C.	40	Automobile	52	Coma. Bleeding nose	105–70	22	10	12	Bloody	
				and ear		16	10	8		
L. M.	42	Auto-truck	50	Coma. Paralysis right	125–85	40	20–30	10	Clear	Improved
			60	side of face. Head-ache		20	6 times	8	Clear	
						14		6	Clear	
C. S.	30	Freight car	54	Comatose	130–90	28	15	16	Bloody	Recovery
			76	Headaches		24	10	14	Bloody	(4 weeks)
			96			14	10	10	Clear	
S. D.	8	Auto-truck	110	Coma. Paralysis right	85–54	30	15	18	Bloody	Paralysis
				side. Loss of mem-ory. Irritability	83–56	22	15	14	Cloudy	clearing.
					88–58	8	10	6	Clear	Memory regained
C. F.	30	Slugged	50	Coma. Meningismus.	135–65	20	10	9	Bloody	Mentality
			60	Headaches	105–65	16	10	7	Bloody	clear
					12	10	6	Clear	Recovery	
E. S.	13	Auto	88	X-ray. Transverse	104–44	20	10	8	Bloody	
	1st d.		100	Fracture frontal bone. Unconscious. Lacera-tion of scalp. Vomit-ing					in 3 tubes	
	4th d.		60 after puncture		122–80 after puncture	16	10	10	Blood tinged	Improved
			62		110–70					
	6th d.		60		110–80	12	10	4	Slightly tinged	Recovery
C. B.	45	Auto	100	Coma, 2 days, bled from	106–70	22	15	6	Clear	Recovery
	10 days after injury			mouth	after puncture 114–86					
			Pulse 84 after puncture	Discoloration behind right ear, headaches		15	10	6		
M. S.	59	Fall downstairs	120 then 112	Temperature 103	150–80 then 132–70	12	15	7	Clear	Recovered from head injury. Died later of pros tatic abscess
G. M.	20	Riding motor cycle and collided with auto	68	Unconscious one	138–90	6	5		Clear	Recovery
			68	hour	138–90					
F. H.			84 then 86		112–60 after	18	10	6	Bloody	Recovery
					114–60	12	5	6		
A. E.	36	Found on R. R. tracks 12 days before	80	Paralysis of ex. rect.	150–84	18	15	8	Clear	Psychopathic
			80	of eye	142–80	16	10	7		
	45		90	Laceration of scalp	130–90	10	15	4		
			90	concussion. Acute alcoholism	130–90					
F. S.	56		100	Laceration of scalp	86–46	6	4		Clear	Recovery
			100	concussion	86–46					

ACUTE BRAIN INJURIES—SEVERE CASES—*Continued*

Case	Age	Injury produced by	Pulse	Symptoms	Blood pressure mm.	Cerebro-spinal fluid pressure mm.	Amount with-drawn c.cm.	Pressure after-ward mm.	Fluid	Result
S. F.	25	Fall off roof of moving train	68	Laceration of scalp, bleeding from nose	150–70	22	20	6	Bloody	
	1st d.				174–70					
	14th d.		80		130–80	40	15	18		
			then 96		132–80					
	17th d.		100		120–78	22	35	2		
			100		108–66					
	18th d.		Slight temperature	Decompression performed						
	19th d.		100		130–70	3	20	6		Discharged
			90		128–70	14	10	6		recovered
H. K.	60	Shot himself through frontal lobe	54	Unconsciousness	120–65	15	20	3	Bloody	Recovery
				Decompression, operation. Ligated right middle men. artery drained subdural region	140–95	8			Clear	
E. W.	25	Fall from wagon striking back of head	72	Headache. Drowsiness	156–105	13	8	5	Bloody	Recovery
			84	Unconsciousness.						
			76	Temperature 103. Mentality clear, no headache						
										Recovery
M. Z.	29	Struck on front of head with club	48	Restless. Susp. skull	150–90	36	15	18	Bloody	
			56	fracture. Comatose. Beginning papilloedema, conscious,		18	10	10	Slightly bloody	
		2 days later	73	headache	148–80	25	20	6	Yellow	
		10 days after injury	76	Mind clear, no head-		20	5	10	Clear	Improving
			80	ache						
		20th day	72			10	5	7	Clear	Recovery
J. O.'C.	53	Blow on head with club	96	Aphasia. Laceration of	158–88	18	15	3	Clear	
	1st d.			scalp (left)						
	2nd d.		84	X-ray shows linear	158–88	24	20	4	Bloody	
			60	fracture left parietal bone. Paresis of right arm. Talks a few words					in 3 tubes	
	5th d.		72	Slight headache	164–94	18	15	6	Bloody	
			76							
	8th d.		70	Returning use of hand.		12	10	6	Yellow	
				Temperature 101 F.						Recovery
	18th d.		70							
S. H.	65	Auto?	80	Fracture right parietal bone. Convulsions.	140–75		5		Bloody	
			60	Bleeding from right	176–90					
				ear. Irrational	150–78					Recovery
C. B.	40	Street car	100	Coma. Ecchymosis left	118–72	20	30	10	Slightly	Psychopathic
	1st d.		88	eye. Left hemiplegia.					bloody	
	2nd d.		60	Irrational		10	10	4		
	3rd d.		52							
J. O.	23	Auto	80	Stuporous	125–75	16	5	10	Bloody	Recovery
O. S.	29	Found on sidewalk	80	Lacerated left eyelid. Stuporous 3 days	135–70	10	5	6	Bloody	Recovery
W. R.	65	Auto	100	Unconscious	150–90	25	10	15	Clear	
	1st d.		60	X-ray negative		22	10	10	Bloody	
	4th d.		72	Aphasia		12	5	6	Bloody	
	7th d.		100	Right pupil small						
	15th d.		80	Ecchymosis right eye		15	10	6	Yellow	
	25th d.		72	Clear mentally		15	10	6	Clear	
	35th d.		70	Speech returning		10	5	7	Clear	Recovery
M. S.	3	Auto	126–100	Laceration of scalp	110–60	18	10	8	Bloody	Recovery
				Skull fractured		12	7	6		
W. B.	6	?	90	Skull fractured	114–60	22	10	10	Bloody	Recovery
			110			14	10	6		
F. d. M.	33	Street car	72	Coma. 17 days	150–70	20	20	10	Bloody	
	1st d.			Bleeding from nose,						
	2nd d.		62	mouth and left ear.	130–70	24	30	12	Bloody	
	3rd d.		56	X-ray showed fracture	125–76	28	30	14	Bloody	
	6th d.		68	left parietal.		18	20	8	Yellow	
	12th d.		72	Mentality clearing	125–75	8	10	5	Clear	
	18th d.		72		125–75	7	5	5	Clear	
	24th d.		72	Good condition	125–75	7				Recovery
C. G.	60	Fall from wagon	72	Comatose. Bleeding	128–85	10	20	6	Bloody	
	1st d.		60	from nose. Headache	160–100	12	20	6	Yellow	
	3rd d.		64	X-ray shows fracture		8	5	5	Clear	Recovery
	6th d.		76	of right parietal bone						
	14th d.									

ACUTE BRAIN INJURIES—MILD CASES

Case	Age	Injury caused by	Pulse	Symptoms	Blood pressure	Cerebro spinal fluid pressure mm.	Fluid	Result
J. S.	65	Fall from street car	60	Coma		10	Clear	Recovered left hospital third day
W. W.	28	Fall in front of auto; alcoholism	108	Coma		8	Clear	Recovered left second day
T. S.	29	Fall from auto	90	Stuporous		8	Clear	Recovered left second day

CHRONIC OR CONTINUED HYPERTENSION

J. K.	27	Jack striking head	84	Headache Dizziness Vomiting	110–70	19	Clear	Recovered 10 c.cm. removed Symptoms relieved
J. W.	37	Axe striking head	74	Headaches Inability to work; depressed skull fractured		18	Clear	Unimproved

FATAL CASES

Case	Age	Injury produced by	Pulse	Symptoms	Blood pressure mm.	Cerebro-spinal fluid pressure mm.	Amount withdrawn c.cm.	Pressure afterward mm.	Fluid	Result
?	?	Skull fracture	100	Coma. Bleeding, left ear	?	15	10	3	Bloody	Death in 12 hours
T. S.	3½	Fall out of fourth story window	?	Fractured skull	?	13	?	?	Bloody	Death in 24 hours
H. B.	23	Hit on head with rock	58	Coma. Hæmorrhage from left ear and nose	160–80	26	20	14	Bloody	Death in 5 days
M. R.	50		100	Coma. Lacerated scalp Hæmorrhage left ear	90	10	5	2	Bloody	Death in 24 hours
F. J.	50	Fall downstairs	72	Coma. Skull fracture; temperature 103. Exophthalmus. Bilateral blurred discs	156	20	15	6	Bloody	Decompression Operation. Death in 12 hours
H. S.	60	Fall backward after a dizzy spell. One week before entrance	66	Coma. One week. Skull fracture. Chronic nephritis	195–110	40	30	10	Yellow	
	2nd day 4th day		64	Conscious. Headache	200–120	60	20	7	Yellow	Death
F. F.	30		56	Coma. Pupils unequal Exophthalmos	160–84	0	20	0	Bloody	Died 2 hours after entrance
F. A.	50	Street car	82 100	Comatose. Delirium tremens	128–80 118–72	22	10	6		Died of œdema of lungs

Second, there are those cases, rather common, of mild injury to the brain with unconsciousness—that show a normal or slightly increased cerebrospinal fluid pressure up to 12 millimeters and the absence of blood in the spinal fluid. These recover in 24 to 72 hours as a rule. Occasionally, one of them continues to have symptoms of headache, dizziness, and general symptoms of neurasthenia and develops a serous meningitis with increased intracranial tension. These are usually relieved by the repeated withdrawal of small amounts of cerebrospinal fluid. They constitute 26.6 per cent of the cases and there were no deaths.

Third, there are those cases of moderately severe cranial injury with or without skull fracture but with contusion of the brain. There is blood in the spinal fluid and the pressure is increased beyond 12 and up to 22 millimeters of mercury, that is 2 or 3 times the normal pressure. There may be focal symptoms of paralysis of the extremities or of the face, or injury of the cranial nerves. The reflexes are altered. The temperature usually is increased and the coma or con-

vulsions persist for several days. It is here one's careful judgment comes into play. It is with this class of cases that I have achieved good results by carefully and slowly withdrawing from 10 to 20 cubic centimeters of fluid at intervals of 12 to 24 hours always watching the pressure of the cerebrospinal fluid so that it is decreased not more than one-half. Whether or not I am justified in this procedure, time alone can tell. The immediate results have been satisfactory. Sharpe advises subtemporal decompression in pressures over 16 millimeters. I believe this is not necessary. These constituted 42.2 per cent of the cases. The mortality in this group was 3 per cent.

The fourth class are those very severe injuries of the brain usually associated with skull fracture that show a cerebrospinal fluid pressure over 22 millimeters. Usually between 22 and 30 millimeters and sometimes as high as 40 millimeters. Here, a subtemporal decompression usually has been done. And yet, I am not convinced that subtemporal decompression does as much as lumbar drainage. They constitute 20 per cent of the total number and the death rate was 6 per cent; making a total death rate for the whole series of less than 25 per cent.

EXPERIMENTS

The following experiments were undertaken to determine the effects of pressure applied to the brain above and below the tentorium cerebelli. My thanks are due Prof. F. C. Becht of the Department of Pharmacology of Northwestern University Medical School for his kind co-operation.

In conducting these experiments on animals we recorded the blood pressure from the carotid artery, heart rate from the femoral vein and respiration from the side tumor in the respiratory tambour. A hole was drilled through the arch of the atlas and the dura incised so that the pressure could be applied directly to the medulla. A similar hole was drilled in the parieto-occipital region. Each hole was closed by screwing into it a brass tube. Both tubes were connected by means of a T-piece with a pressure reservoir filled with warm physiological salt solution. Clamps were adjusted so that pressure could be applied at will either over the medulla or over the temporoparietal region.

Graph 1 is a tracing secured from an animal weighing 9 kilos under ether anæsthesia. The top record is the respiration; the second shows the heart rate; the third the carotid blood pressure and the fourth the intracranial pressure. The lines at the bottom represent the signal and base lines of the graph. As can be seen from these tracings pressure applied over the medulla produces, first, a stimulation of respiration and a slight rise in blood pressure with the heart rate remaining practically unaffected. Second there is a decrease in respiration and fall in blood pressure and a marked slowing of the heart rate, changes which return practically to the normal when the pressure is released.

Graph 2 is a second tracing from the same animal in which pressure was applied to the brain in the temporoparietal region. The pressure applied is exactly the same as that applied in the tracing No. 1, but there is no change either in respiration, blood pressure, or heart rate.

Graph 3 is a repetition of the experiment shown in Tracing No. 1 and the results are practically identical there being first a slight rise in blood pressure, no change in heart rate and a slight stimulation of respiration followed by a decrease in respiration and slowing in heart rate and a falling in blood pressure. This graph shows that the failure of the change to appear in Tracing No. 2 is due to the difference in the application of the pressure and not to a decrease in the activity of the central nervous system.

These three graphs show clearly that the slowing of the heart rate and the change in blood pressure is a phenomenon of medullary compression, and therefore are likely to be a late manifestation of skull fracture where the injury lies in the central nervous system cephalad to the tentorium cerebelli.

CONCLUSIONS

The following conclusions may reasonably be deduced from observation of the clinical cases and from the experimental work on dogs.

1. In most acute injuries of the brain, the cerebrospinal fluid pressure is a fair index as to the severity of the lesion. Dependable prognosis can be made by any increase or decrease of this pressure.

2 A new clinical classification of injuries of the brain based upon cerebrospinal fluid pressure alone, as shown by the mercury manometer, is superior to the accepted classification of concussion, contusion, and compression.

3 The pathogenesis of acute injuries of the brain demonstrates that the principal effect of the œdema of the brain and hæmorrhage is to interfere with the absorption of cerebrospinal fluid by the usual paths; this sets up a vicious circle causing further pressure on the brain by the accumulating fluid in the basal cisterns below the tentorium cerebelli and in the lateral ventricles which presses the brain upward against the dura and produces cortical anæmia. The cortical anæmia, if unrelieved, quickly leads to gliosis causing lasting changes in the character, disposition, and mentality of the patient, if he recovers from the brain injury.

4. The relief of the increased pressure on the brain and the re-establishment of the normal path of absorption of the cerebrospinal fluid can be obtained by repeated lumbar drainage—which in acute injury cases is absolutely without danger.

5. Lumbar drainage is superior to subtemporal decompression in relieving pressure below the tentorium cerebelli and has the further advantage that it leaves no mutilating skull defect. The use of concentrated salt solutions intravenously lowers cerebrospinal tension but does not remove blood.

6. Experiments upon dogs, producing pressure on the cerebrum and on the medulla, show that the pulse, respiration, and blood pressure are affected only when the medulla is compressed. Therefore, to wait for these changes as an indication for operation on the cerebrum in acute cranial injury is to court disaster.

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AN ANALYSIS OF THE END-RESULTS IN TWO HUNDRED THIRTY-TWO HYSTEROMYOMECTOMIES

With Special Reference to Ovarian Conservation

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THE following is an analysis presenting the end-results obtained in a series of 232 patients upon whom supravaginal hysteromyomectomy was performed. The study was undertaken in the hope of shedding some light upon the fate of conserved ovaries, in cases in which hysterectomy was necessary and upon the ultimate comfort of such patients as compared with those from whom both ovaries had been removed. It is unnecessary here to consider in detail the many arguments for and against ovarian conservation in this class of patients. It has been asserted that conserved ovaries are likely to undergo cystic degeneration and give rise to pain; that they do not functionate, and, at best, that their life is ephemeral; that every conserved ovary is a potential factor for subsequent trouble; and that, in general, better results can be obtained by routine excision of these organs.

In our study only those cases in which the myoma was the principal pathological lesion were included, no patients who had passed the menopause at the time of operation being considered. Of the 232 cases studied, both ovaries were conserved in 90; 81 had one ovary removed; and in 61 a bilateral oophorectomy had been performed. Obviously patients who had recently been operated upon could not supply the desired information. For this reason only such cases as had been operated upon at least one year previously were utilized.

A questionnaire was sent to 374 patients. A considerable proportion could not be traced, as many of the patients had been operated on 5, 10, or even 13 or more years before. About 20 per cent of the patients included in this report have been interviewed personally and examined. A point to be noted is that the results obtained by the latter method are more favorable to ovarian conservation than are those obtained by the questionnaire. Patients will frequently answer one or more questions in a questionnaire in the negative because they attribute the symptoms from which they suffer to the operation or to the pelvic lesion, when, in fact, they are due to entirely different causes. Thus, in answer to a written inquiry, a patient may state that her general health is poor, a statement that may be true. Her poor health, however, may be due to a cardiac, renal, or other lesion entirely foreign to the condition that necessitated the operation.

In an investigation dealing with so complex a problem as the menopause, it is extremely difficult to formulate a questionnaire that will cover all points satisfactorily. Under such circumstances it is impossible, in many instances, correctly to interpret the cause of the symptoms and to determine with certainty whether they are due to the menopause or to some other condition.

This is exemplified by our inquiry regarding nervousness. Many patients answered this question in the affirmative, but it is evident that this symptom may be due to a variety of conditions, and is undoubtedly present in a considerable percentage of women who have never suffered from a pelvic lesion.

Nearly every symptom from which a woman may suffer as the result of an artificial menopause produced by a surgical operation may, if considered singly, be accounted for by conditions other than that of castration. It is only by a study of the combined symptoms—noting their time of onset in relation to the operation, their severity, and many other points—that a satisfactory conclusion can be arrived at.

The fact that the age at which the menopause occurs in the normal woman varies, and that it also differs markedly in severity in different individuals, adds materially to the difficulty in framing a questionnaire

such as ours. At the time of operation many of our cases were approaching the age at which the menopause should normally occur. This event would, therefore, probably have occurred, in a definite proportion of the cases, in the interval between the operation and the receipt of the questionnaire, even if no operation had been performed. For similar reasons a certain percentage of women would probably state that, during this period, they had suffered more or less severely from the menopause, even if no operation had been necessary. The personal equation also enters largely into the character of the answers obtained; thus some patients will complain greatly of a symptom that another will practically ignore. These and other sources of error should be taken into consideration in the study of these cases.

The effect of bilateral oophorectomy upon the sexual life of the woman is an important factor. This subject cannot be determined satisfactorily as the result of a questionnaire, and has not been referred to in our inquiry. Among the patients whom it has seemed feasible to question upon this point, quite divergent results have been found to exist. Viewed in the aggregate, and excluding certain perhaps exceptional cases, the results have been very decidedly in favor of ovarian conservation. The arresting of the sexual life, the senile changes, such as atrophy, drying, etc., that take place in the vagina, have been notably absent in those patients upon whom ovarian conservation has been practised. Atrophic changes in the vagina occur with such regularity following bilateral oophorectomy that we have made it a rule not to perform plastic operations for minor degrees of laceration upon patients in whom the removal of both ovaries is necessary. These conditions, and occasionally a mental attitude of inferiority or degradation, due to the patient's belief that she is unsexed, or in this respect senile, have been encountered in a certain number of patients in whom both ovaries have been excised.

Three important conclusions have been arrived at, namely: (1) That excellent end-results may be obtained by performing hysteromyomectomy, whether or not ovarian conservation is practised; (2) that the severity of symptoms occurring at the menopause is dependent more upon the patient's individual temperament than upon her age; and lastly (3) that conserved ovaries rarely give rise to trouble.

That excellent results may follow hysteromyomectomy, whether or not the ovaries are conserved, is well known, and is amply borne out by the fact that over 99.5 per cent of all our cases studied stated that they were either cured or improved by the operation.

Of the 212 patients who answered the question regarding their general health, only 2 stated that it was poor, and the family physician of one of these patients informed us that the ill health of his patient was due clearly to an advanced cardiac lesion. This patient had been operated upon 12 years previously, and no symptoms referable to the pelvis have occurred since the operation. No information regarding the condition of the other patient could be obtained.

The statement previously made, that the severity of symptoms attending the surgical menopause is dependent more upon the temperament of the patient than upon her age is difficult to prove by a statistical study. It has, however, been one of the most striking features of our investigation, and particularly emphasized in those patients who have been personally interviewed.

We have observed instances in which a bilateral oophorectomy has been performed upon young women, often still in their twenties, in whom, although the menopause has occurred, the attendant symptoms have been mild and given rise to little or no trouble. On the other hand, some of the most severe cases have occurred in women past 40 or 45 years of age. Unfortunately, even after a close study of the individual patient has been made, it is sometimes impossible to forecast just how troublesome the surgical menopause will be in her case. As a general rule, the highly strung, nervous or neurotic individual suffers most, whereas the phlegmatic asexual woman will experience little discomfort. Women differ markedly in this respect.

Reference has previously been made to the fact that the conserved ovary may undergo degenerative changes, and thus give rise to various distressing symptoms that may make a second operation necessary. This point has been emphasized by some operators, who therefore, recommend that a bilateral oophorectomy be performed whenever removal of the uterus becomes necessary. Our own experience does not bear out this finding. We firmly believe that too much stress has been laid on this point.

In the present series of 232 patients, ovarian conservation was practised upon 171 cases (in 90 cases both ovaries were conserved and in 81 an unilateral oophorectomy was performed) and 261 ovaries were spared. In not a single case was a second operation for the removal of the conserved ovary required. These figures furnish strong arguments for ovarian conservation, for if the retained ovary gives rise to no further symptoms, its removal cannot be recommended. Even granting that this series of cases may have been particularly fortunate in this respect, the evidence would certainly go to prove that the proportion of conserved ovaries that give rise to subsequent trouble is not great. We are firmly convinced that in patients who have not passed the menopause the ovary is a most important organ, and should not be removed unnecessarily.

We believe that successful ovarian conservation is largely dependent upon three factors:

1. *The ability of the surgeon to judge the condition of the ovary in situ.* It is plainly unwise to spare an ovary that is the seat of disease that will continue to progress after the uterus has been removed. Thus a severely inflamed ovary, or one the seat of a neoplasm, should be removed, whereas an ovary that merely presents a few adhesions, but that is otherwise normal, should be spared. It is only by considering the individual patient, and by careful correlation of the symptoms and the pathological process that is present, that accurate conclusions can be arrived at. An important guide in this respect is the amount of pain the patient has suffered prior to operation. Marked pain in the region of the ovary, or severe dysmenorrhœa, particularly of the ovarian type, is an indication for oophorectomy. Every operator should familiarize himself with the macroscopic and microscopic pathological changes that occur in the ovary. Without laboratory study, no surgeon is capable of judging pathological conditions *in situ*, and this is of the greatest importance in deciding whether or not to practise conservation in any given case.

2. *The maintenance of an adequate blood-supply for the conserved ovary.* This is of the utmost importance. If the character of the operation is such as materially to injure the blood supply of the ovary, conservation of the organ is hazardous, and subsequent trouble is prone to occur. The blood supply is less likely to be impaired if the fallopian tube is also conserved. In dealing with myomatous tumors of the uterus, this is usually a feasible procedure. In about one-third of all myomata that come to operation, the adnexa are inflamed, but the inflammatory process is more likely to be confined to one side than in either the gonococcal or the tuberculous varieties of salpingitis, and for this reason in the majority of cases, at least one normal tube and ovary are present. By practising conservation of the corresponding fallopian tube not only is a better blood supply secured for the ovary, but a more rapid and neater operation can be performed.

3. *The maintenance of the ovary in good position after operation.* If the conserved ovary is allowed to prolapse into Douglas' cul-de-sac or is twisted upon its pedicle in an attempt to suspend it, the blood supply is interfered with and painful symptoms are likely to develop.

It should be remembered that good results can undoubtedly be obtained by performing hysteromyomectomy with ablation of both ovaries, and for this reason a diseased ovary, or one in which the blood supply has obviously been interfered with, had best be removed. This, however, is not the condition that is present in the majority of these cases. It is our belief, that in the average case, there is no excuse for the removal of normal ovaries.

CONCLUSIONS

1. Hysteromyomectomy is productive of excellent end-results whether or not ovarian conservation is practised. Of all patients in our series, over 99.5 per cent were cured or improved, and over 83 per cent declared that their general health was good or improved one year or more after operation.

2. Better end-results and greater comfort to the patient can be secured as the result of ovarian conservation.

3. Everything being equal, better end-results follow the conservation of both ovaries than the retention of one, but one ovary is far better than none.

4. Conserved ovaries seldom give subsequent trouble. Among 171 cases in which ovarian conservation was practised, 261 ovaries were conserved, and in none of these patients was a second operation for the removal of the ovary necessary. This is a strong argument in favor of ovarian conservation in this class of cases, for if the conserved ovary does not give trouble, there can be no excuse for its removal.

5. That conserved ovaries may give subsequent trouble is conceded, as is also the fact that the series of cases quoted may have been unusually fortunate in this respect. Successful ovarian conservation depends upon the condition of the ovary at the time of operation, the maintenance of an adequate blood supply, and the retention of the ovary in its normal position.

6. We believe that undue emphasis has been placed upon the frequency of cystic and other forms of degeneration in conserved ovaries, and that attention to the points just mentioned will largely abrogate such disturbances.

7. Bearing in mind the fact that good results can be secured by performing bilateral oophorectomy, it is often better to sacrifice a doubtful ovary than to spare it. This is a point, however, on which each case must be judged individually.

8. When both ovaries are removed, the surgical menopause is by no means severe in all cases, those patients who suffer unduly being in the minority.

9. The age of the patient is not an unfailing criterion as to the severity of the surgical menopause in any given case Young women will sometimes bear the loss of both ovaries well, whereas some of the most severe phenomena of the surgical menopause encountered in this series have occurred in patients past 40 years of age. This does not imply that the age is an unimportant factor in considering the question of ovarian conservation. Other things being equal, there is no doubt but that younger women suffer more severely as a result of a bilateral oophorectomy than do those who are older.

10. A more important guide than the age, however, is the temperament of the individual patient. The highly strung, neurotic woman is likely to suffer more severely than her more phlegmatic, asexual sister.

11. Each case should be individualized. The temperament of the patient should be studied, and a correlation of this with history and the pathological process found at operation should determine the type of operation to be performed.

12. Conserved ovaries functionate.

13. Even in those patients in whom the ovary does not functionate permanently, the occurrence of the surgical menopause is less abrupt and severe than in those women upon whom a bilateral oophorectomy has been performed. Among the former class of cases the artificial menopause generally resembles the normal menopause more closely than does that following the removal of both ovaries.

RELATIONSHIP BETWEEN HISTOLOGICAL STRUCTURE AND BIOLOGICAL ACTIVENESS OF GOITER TISSUE[1]

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UNTIL the end of the past century goiter was regarded as an entity in etiological research and no attention was paid to the histological structure of the gland in the individual case. Through the research work of Greenfield, Haemig, Askanazy, L. R. Mueller, and others, through our own investigation on thyroiditis, and, since 1910, through the work of Kocher and Howald, Plummer, Wilson, special cell changes have been noted in the goiter of Graves' disease, proving that the cell changes in the different types of goiter should be given due consideration.

In 1905 Aeschbacher, working under my direction, pointed out that results obtained could be interpreted only by means of combined chemical and histological investigation. He studied the material in our clinic, noting the relationship between the histology and the iodine and phosphorus content of the thyroid gland. The most extensive work in this direction has been done by Oswald and Plummer.

When biological methods began to be employed in studying thyroid function, there followed a demand for research work combining physiopathology and histology. Graham was the pioneer in this work. He tested the effects on tadpoles of the iodine contained in adenomatous tissue and normal tissue and found that with adenomatous tissue it was the same but less pronounced than with normal tissue. In either case it seemed to depend upon the amount of iodine in the tissue. On the other hand he was unable to determine a constant relationship between the physiological effect of the tumor substance, the percentage of iodine contained, and the histological character. Graham confined his research to adenomata. Wegelin and Abelin went farther. They investigated the biological effect on tadpoles and normal thyroid tissue and of thyroid tissue of different histological structures, from patients of different ages, also determining the amount of iodine the tissue contained. They came to the con clusion that the effect of struma diffusa, especially in its colloid form, and also of adenomatous goiter, resembles largely in many cases the effect produced by normal gland, with the exception of struma neonatorum which, as a rule, contains no iodine and has no specific effect.

This proves that growths which must be characterized as real tumors contain substances corresponding biologically to those in normal gland. But it has not been proved, as the authors themselves emphasize, that these substances are beneficial to the body. Neither do these experiments inform us in what quantity the substances enter into the circulation of the blood. Furthermore, as has been shown by Gley, substances which have been obtained experimentally from a gland may not, without reserve, be identified with the secretion of the gland.

We therefore decided to make a further investigation of our cases, examining, by means of the same biological method as used before, not only goitrous tissue but also venous blood from the thyroid gland and at the same time blood from any other large vein belonging to the systemic circulation, for instance, from a vein in the arm. These experiments were conducted in our laboratory by Dr. Hara. He used principally common goiter and the goiter of cretins.

Let me state here that the study of thyroid gland tissue and of blood by means of a biological method (Laewen-Trendelenburg method) has hitherto been made only once and then by Dr. Eiger at the Physiological Institute in Berne. His work covered seven cases of Graves' disease and two of common goiter, without considering the histological structure of the struma.

We did not use the thyroid tadpole and Laewen-Trendelenburg methods, but used a method worked out under the direction of Professor Asher by Dr. Streuli and Dr. Duran

[1] Presented before the Clinical Congress, October, 1921.

at the Physiological Institute in Berne. This method is based upon the observation that rats, when fed or injected with normal thyroid gland, become hypersensitive to a deficiency of oxygen. After being fed or injected with thyroid preparations, the rats are placed beside control rats under a bell jar attached to an air pump and are observed at different degrees of air rarefaction. Thyroidectomized rats bear the rarefied air longer than do healthy rats, while rats previously treated with thyroid preparations bear it less long. Careful attention to all the details of the experiment affords a more exact criterion for this senstiveness to oxygen than might be supposed.

In brief, the experiments were conducted as follows: Two rats were injected, one daily for 3 consecutive days with 2 cubic centimeters of blood serum taken from an arm vein, the other similarly with thyroid venous blood. A third was fed for 3 days with a total of 60 grams of tissue from the same struma. The experiments were made thirty-one times with blood from arm veins, thirty-one times with thyroid venous blood and thirty-six times with thyroid substances. Twenty-two common strumas, four Graves' strumas, and eight cretin strumas were subjected to examination. Among the common strumas there figured both strumata colloides diffusa and nodosa, and strumata parenchymatosa diffusa and nodosa. The cretin goiters were of the adenomatous type, in two cases with a slight colloid amount.

Before discussing the results of our experiments, a few remarks based on 30 years' study of the thyroid problem may be helpful.

RELATIONSHIP BETWEEN HISTOLOGY AND FUNCTION OF THYROID AS KNOWN TODAY

1. The epithelium of the thyroid gland produces a secretion called globular *colloid* which contains, in an albumin-like vehicle, colloid and crystalloid substances which are transmitted to the blood, perhaps also to the lymph vessels. Iodine plays an important part in the construction of the substances. There are also in the gland, substances which without containing iodine, manifest most important gland effects.

2. The epithelial cells of the thyroid gland also contain iodine and probably some part of the symptom producing substances, so that the iodine and such substances may be found in glands containing no colloid. Whether the epithelial cells supply the capillaries with these specific substances direct without taking the round-about way of the colloid, has not been solved even by means of either physiological or histological study.

3. The amount of colloid contained in the thyroid vesicles depends on the proportion between colloid production and colloid resorption. It represents, in a sense, the cash index, without permitting us to judge of the height of the output, i.e., the amount of colloid really produced by the thyroid gland. In the normal gland there is a regulating mechanism that may be called the "threshold of resorption," whereby the level of the colloid reserve in the gland is maintained. Every modification of this threshold, i.e. of the colloid stored in the gland, denotes a disturbance of eu-thyroidism. Such conditions are found—

a. At birth, when the newborn, deprived of the influence of the maternal thyroid, suddenly has a great need for thyroid secretion and the threshold temporarily sinks, leaving the reserve nil. In the course of a few weeks or months the threshold of resorption is re-established and is maintained during life until old age, when in consequence of less need for the secretion, it again sinks.

b. During adolescence and pregnancy, when greater demands are made on the gland.

c. During various acute illnesses, for instance, contagious diseases, intoxications, and burns, the threshold sinks, either because more colloid is required and its resorption is consequently accelerated, or because toxic changes in the gland cause a diminuation of colloid production.

4. The histological picture reveals the consistence of the colloid. We distinguish—

a. Thin liquid colloid, of net-like appearance, difficult to stain;

b. Thick liquid normal colloid, not, or only slightly vacuolized: usually eosinophilic, more rarely basophilic.

c. Old, thickened colloid, strongly basophilic, often laminated.

The first type is found in cases of Graves' disease, intoxications, and infections, the second in the normal thyroid gland and in colloid goiter, the third especially in cretin-goiters, and in senile thyroid glands.

The iodine index and biological effectiveness of the different forms vary also when the colloid appears similar. The capacity of the colloid for taking stain is nevertheless, in a general way, in a reversed relation to its physiological activeness.

5. The histological picture of the epithelial cells reveals the degree of activeness of the gland.

6. If the body is under normal thyroid influence, we speak of *eu-thyroidism*. If the body is constantly under increased thyroid influence, we speak of *hyperthyroidism*. The threshold of resorption may be normal, but is usually lower, and the "exchange" of colloid is increased.

If, on the contrary, there is a deficiency of thyroid secretion, we call the state hypothyroidism. In this case the threshold of resorption is usually also lower than normal as the gland contains little or no colloid. The "exchange" of colloid is decreased.

We will not go into the question, as to whether the causation of cretinism is exclusively due to disturbance of thyroid function, or whether the struma "noxe" has, in part, a direct injurious effect on the different organs. (Virchow-Bircher.)

The problem as to whether hyperthyroidism and hypothyroidism are due merely to a *plus* or *minus* or to a *qualitative* change in the secretion, has not yet been solved, either by biological and clinical researches or by histological facts.

Such a qualitative change, a "dysfunction," might be due to abnormal mingling of the various normal components of secretion (heterogenic or relative dysthyroidism), or to the origin of substances not occuring in normal secretion. (Genuine or absolute dysthyroidism.)

It is probable that pure hyper-and hypothyroidism, as well as hyper- and hypothyroidism associated with dysthyroidism, occur. According to Plummer and Wilson the "toxic adenoma" might produce a pure hyperthyroidism, while the true exophthalmic goiter might be the result of a state of dysthyroidism.

7. The histological structure of goiters varies according to the part of the country. In certain countries, especially in level regions, the diffuse colloid goiter, with and without hyperthyroidism, and the exophthalmic goiter predominate. In more mountainous countries the toxic goiter is an exception, and the nearer one approaches the center of the endemic area, the less he meets with the colloid goiter. It is replaced by the colloid-poor, diffuse, parenchymatous goiter in childhood and by the adenomatous parenchymatous nodular goiter with its degenerative forms in adults.

The cretin struma exhibits the gravest effects of the goiter-producing agent. Our own study of 50 such cases show that about nine-tenths of the strumas are quite, or for the most part, adenomatous with or without histological signs of activeness. The blood vessels are occasionally strongly developed, and among cretin strumas we meet with the most extensively vascularized adenomata that are to be found. As Bircher has already pointed out, cretin strumas contain thyroid substance which may not, as a matter of course, be considered incapable of thyroid function.

As regards the biological functions of the various types of goitrous tissue, we only know what the aforementioned experiments of Graham, Wegelin, and Abelin have taught us. The thyroid function of cretin strumas has not yet been investigated.

RESULTS OF EXPERIMENTS

The results of our researches and experiments on rats may be summarized as follows:

1. Feeding rats with *goitrous substance* always causes an increased sensitiveness to lack of oxygen. The strongest was found with exophthalmic goiters containing a little colloid, and then in decreasing order with non-toxic colloid goiter, general parenchymatous enlargement (adenomatosis according to Wilson) adenomatous goiters from non-cretins and the same from cretins.

2. The injection of *serum from thyroid veins* produced in all cases a positive reaction, but less strong than did thyroid feeding. The order of succession was the same. The blood from veins of common goiters is distinctly more active than that of cretin goiters.

3. *Blood from the arm veins* is distinctly active in the cases of colloid goiter and parenchymatous enlargement, but on the other hand not distinctly in cases of adenomatous goiters neither from noncretins nor from cretins.

4. In three out of four cases of dwarf cretins with *thyroid atrophy* (without goiter) the *blood from the arm* produced a decrease in the sensitiveness to lack of oxygen.

DISCUSSION OF RESULTS

We are not surprised at the great activity of the tissue from exophthalmic cases. The histological examination showed in all cases definite colloid contents. It is possible that the cases of exophthalmic goiter with less colloid would be less active than nontoxic colloid goiter.

It is obvious that the common struma diffusa colloids and parenchymatosa of noncretins, i.e., of individuals in a condition of eu-thyroidism, has about the same effect as the normal thyroid glands, as it plays the same part in the human organism. Seeing that in this case also, glands deficient in colloid are sometimes almost as effective as glands rich in colloid, we must assume with Graham, Wegelin and Abelin, that not only is colloid active, but that gland substance deficient in or without any colloid may contain much active substance.

It is eminently interesting that cretin strumas, such as occur in the worst cases of cretinism, are biologically active, even after every bit of nonadenomatous tissue has been removed.

The effectiveness of goiter substance does not, by any means, prove that its secretion is of benefit to the body. The blood experiment alone could give us information on this point.

As a result of the blood experiment we emphasize first that in the thyroid *vein* blood of every type of common struma the presence of active substance could be proved biologically. With the establishment of this fact one of the most important postulates of endocrinological research has been fulfilled. Of still greater importance is the fact that its activity can be proved, even if only in a very slight degree, in cases of highly developed cretinism.

Whether this effectiveness is due to the remnants of atrophic thyroid gland substance present in most cretins, or to adenomata, we can not directly decide. If however, we consider the positive results of feeding with adenomata taken from cretins, the histological signs of activeness in several cases and the rich supply of blood to these adenomata, we must assume it probable that cretin adenomata also might furnish active substances.

Certain facts in the endocrinology of cretins suggest that the active substance furnished by adenomata is not identical with the normal thyroid secretion. There is an outspoken dissociation of the main symptoms of cretinism. Dwarfism is more frequent in cases of atrophic thyroid than in cases of cretinism with goiter. Mental impairment may be slight in cases of dwarfism, and on the other hand very marked in cretins with goiters and without dwarfism. There is no parallel, indeed, between mental and skeletal disturbances.

These facts may be explained easily by the assumption that adenomata are able to furnish an active substance showing either absolutely abnormal qualities (absolute dysthyroidism) or abnormal proportions of the normal components of the thyroid secretions (relative dysthyroidisms).

One of the most important facts resulting from our researches, is the establishment of a *biological effect of arm vein blood derived from patients with common goiter* in contrast to the arm blood of non-goitrous people. Should these results be further confirmed, they would serve to demonstrate that the common goiter produces substances which are not destroyed in the small or large circulations and which affect a rat biologically about the same as thyroid secretion, even if the patient presents no signs of hyperthyroidism. These experimental results differ from those of Eiger who employed the Laewen-Trendelenburg method and found no activity, either in the arm vein blood of persons affected with Graves' dis-

case, or in that of patients with common struma. Further experiments will throw light on this point.

Theoretically it would be very important if the results pertaining to the action on rats of blood from arm veins of non-goitrous cretins namely a *decreased* sensitiveness to lack of oxygen, could be confirmed. These results would tend to show that the thyroid gland possesses besides a stimulating action an antitoxic one.

Our researches are on the point of being completed by the study of the iodine and thyroxin action on cretins and by the comparison of the rat test with the tadpole test and basal metabolism.

It seems to me that the study of cretinism is equally as important in investigating the functions of the thyroid gland as the study of the exophthalmic goiter and that the rat test might be, in conjunction with the clinical and histological research, a valuable help toward the solving of the pending problems, especially in regard to the behavior of the blood and to biological activeness of the different types of goiter tissue.

ACUTE PULMONARY ŒDEMA IN LABOR

By FREDERICK G. CORBIN, M.D., C.M., Mendoza Argentine Republic

TWENTY-FIVE years' practice and a search through textbooks and journals have not revealed a case similar to the one reported below. I feel justified, therefore, in presenting this report of a case of acute pulmonary œdema in labor for the consideration of my distinguished colleagues in this congress[1] of medicine.

Mrs. A. D. deS., age, 24; of German parents, married 7 years; of good social position; father, mother, sisters, and two brothers all living and well; does not remember being sick in her life. She had had one child 2 years after marriage. Labor was normal; the child strong and healthy, and never has been sick.

In the month of June, 1915, I was asked to attend patient in confinement in the city of Godoy Cruz, Mendoza. I was told that she had a good midwife and a competent German nurse and that only in case of unexpected complications would I have anything to do.

On accepting the case I asked for an analysis of a 24-hour specimen of urine. This was made by Dr. Munier. Two days afterward I again saw my patient in my consulting room. I must confess that, as I had known her for some 17 years, I did not make an examination; simply talked with her about her pregnancy and as the urine was pronounced normal, I assured her that there was nothing to do but to wait with patience and not to change in any way her mode of living.

About the last of August I was called urgently and found the midwife in attendance. The midwife assured me that there was nothing — that the patient had had pains the night before but that these had ceased and there was no dilation of the uterine cervix. On examination I found this to be true and that the position of the child was normal. An analysis for albumin was made the following day with negative result.

One month later, at 7 a.m. on September 27, I was called again, arriving in company with the trained nurse about 8 a.m. The midwife told us that she had been called at 6, had found dilation, that the position was left occipito-anterior and everything quite normal. Trusting this diagnosis I did not even wash my hands, but sat down beside the patient and began to talk with her and advised her not to make so much voluntary effort as the involuntary forces were sufficient. In spite of this she persisted in making voluntary efforts to expel the child, but I do not think they were more than others use in the same conditions.

A few minutes after my arrival a fine, 3-kilo male child was born; a few minutes later the placenta was normally expelled without abnormal hæmorrhage. After congratulations I retired with the husband to the sitting room leaving in the hands of the nurse and midwife the care and cleanliness of my patient. On retiring from the bedroom not a single thing gave me even a remote idea of what was about to occur.

In about 10 minutes I was called by the nurse who said that the patient was very gravely ill. Her state was truly alarming; her general appearance gave one the idea of imminent death from asphyxia; her pale face covered with perspiration, her cyanotic lips, her nostrils dilating with each inspiration, her anxious expression, and feeble, almost imperceptible voice, all asked for air.

As can be imagined the moment was not propitious for counting respirations, while her pulse was

[1] National Medical Congress, Buenos Aires, 1916.

seventy-five, they must have been about fifty. The inco-ordination between pulse and respiration especially attracted my attention. I at once sat her up in bed and found on auscultation vesicular respiration and innumerable crepitant and subcrepitant râles throughout both lungs, while percussion was normal.

Diagnosis: acute pulmonary œdema.

While preparing an injection of morphine I ordered my two assistants to apply hot turpentine stupes to her chest and back. Her state was so bad that in spite of using boiling water and a good dose of the revulsive she apparently did not notice it. Five minutes after I had entered the room she had received 1½ centigrammes of morphine hypodermatically administered and in another 5 she began to cough at short intervals, while with each attack she brought up a mouthful of a frothy, bloody liquid. In the next half hour she had coughed up 700 grammes of this liquid and at the end of an hour this measured more than a litre.

This expectoration which at first was decidedly bloody, became rose colored and finally clear and crystalline. The pulse reached 100 and my patient was saved. In the afternoon the pulse was 90; no râles to be heard. An analysis of urine next day showed it to be normal. She got up 10 days after and nursed her son for over a year. Up to date she has never been sick.

This is the history of my patient and now let us say something of her disease.

I searched the literature for information regarding such cases and asked my colleagues of long practice regarding their experiences, but neither they nor any works obtainable in Spanish, French, or English could give me more than the following:

In the *Manual of Medicine*, published by Debove and Achard, 1896, is an article by M. Parmentier which mentions acute and general congestions of the lungs, and on page 190 gives among the causes "*des grande efforts surtout ceux de l'accouchment*"—this is all. Did M. Parmentier wish to signify an "acute pulmonary œdema?" I do not think so, because on page 196 he admirably describes an acute œdema and says it occurs in the gouty, arthritics, and Bright's disease, and does not mention pregnancy or labor as a cause. Through the kindness of a colleague I was able to read the thesis of Dr. E. Centenaro presented in 1908 before the Medical Faculty of the University of Buenos Aires "*Accidentes pulmonares durante el embarrazo*" (Pulmonary Accidents during Pregnancy). The paper is very interesting surely, but it refers to œdemata *not in labor* but before and caused by different intoxications.

Among the causes of this terrible disease, in the absence of renal, hepatic, cardiac, infectious disease, or medical intoxications, Albert cites "Purely mechanical causes," and I believe that my case was produced by "spasm of the left ventricle" (Huchard). Grossman says that it may be caused by a perturbation of the "innervation cardiopulmonary," and as a consequence of this a rapid "insufficiency of the right ventricle."

In my case it is impossible to attribute the attack to either the left or the right cardiac cavity but it was undoubtedly due to a spasm or cramp of one or the other; as in spite of careful examination of heart, kidneys and other organs no disease could be found; and again because had it been due to an intoxication as in the cases cited by Dr. Centenaro, the injection of morphine far from curing, would have made the patient worse.

Twenty years ago in Carmen de Patagones I saw an old woman who suffered from aortic disease with attacks of acute œdema. She experienced immediate relief and cure with a single injection of morphine with atropin. The treatment with morphine is very much discussed and while some authors consider it the most appropriate, others think that bleeding, stimulants, strychnine, camphorated oil, adrenalin, etc. are better. Some (Faisans, in Robins, 1912) even condemn the use of opium in any form. This is easily explained because the causes of acute œdema of the lungs are multiple and varied. Robins (1912) cites a long list of causes. My belief is that, as far as treatment goes, one should take only two causes into consideration: intoxication and heart trouble. These really include all the causes given by authors. I do not believe that an œdema, produced by intoxication, whatever may be the cause—whether it be faulty elimination of urea (renal), bile (hepatic), microbes (infectious disease) or poisons, etc.—requires different treatment; the result is the same, namely, toxic bodies circulating in the blood. What should be done? Certainly morphine should not be given. I believe that bleeding and

replacing the blood with physiological serum intravenously is indicated. The bleeding eliminates the poison and the serum dilutes it, while in such cases strychnine, caffein, and other stimulants will help the elimination by natural channels, and at the same time sustain the vital forces.

Let us now examine œdema produced by cardiac trouble — spasm or cramp of the ventricles, as Grossman and Huchard describe. The logical thing in these cases would be to give a dose of morphine and the illogical an injection of strychnine. The first ought to calm the spasm while the second might even produce it.

Apparently no one author has had opportunities to treat cases produced by more than one order of causes, as no one in speaking of the treatment has distinguished between œdema produced by intoxications and those caused by cardiac disease; with the result that some insist that the proper treatment is strychnine and others that it is morphine. The first criticizes the second and vice versa. My opinion is that as the cause in my case was cardiac (cramp) and not toxic, the correct treatment was morphine and it would have been better still if it had been associated with atropin.

This case and the old woman of Patagones, to whom I briefly referred with the same symptoms, treatment, and immediate results, although different as far as the provoking cause, are the only cases I have seen and to tell the truth have no desire to see others.

I reported my case in a paper in Spanish at the National Medical Congress in Buenos Aires, 1916, where it was discussed. At that time no one could recall a similar case.

As my patient again became pregnant and suffered attacks of œdema, finally succumbing to them, I feel inclined to publish the whole history.

Every few months from 1915 to 1920 I saw my patient and often examined her heart. I sent her to specialists in Buenos Aires and had both urine and blood examined several times. The Wassermann tests were negative. No one found anything pathological.

In 1919 she had influenza with severe congestion of lungs but no œdema.

In July, 1920, her husband came to consult me, telling me his wife was about 3 months pregnant and asking me if I thought there would be any danger in her having another labor. I told him I thought there might be and advised him to take her to Buenos Aires and consult the highest authority there, saying that I would be pleased to help in any way. He did so and consulted several professors showing them my address to the medical congress. One and all pronounced her perfectly healthy and laughed at the idea of future attacks or any danger. After a little over a month she came back bringing with her some tonic injections to be given by me intravenously. I never saw the prescription but believed them to have been *Enesol*.

Fortnightly I had her urine analyzed, and carefully examined her heart and blood pressure. She was very well through September and October; pulse between 90 and 100 while her blood pressure was from 90 to 110 milligrams mercury. Nothing abnormal was found in heart sounds. Only one thing was to be noted—a persistent and very great *fear* of an attack as before. She always insisted she would die in her labor. No one could *look* in better health.

In November she had her first attack; after sleeping quietly for an hour she awoke with dyspnœa. I was sent for at once and gave her an injection of one centigram of morphine with 0.5 milligram of atropin. The relief was immediate. She coughed up some 200 grams of rose-colored liquid and in 2 hours she was all right, getting up the next day without a sign of anything wrong. Her pulse when I arrived was 90, with blood pressure 120, and the next morning 100 with 105 milligrams mercury. She was now between 6 and 7 months pregnant; urine normal.

The question of producing premature labor was discussed, but as the effect of the morphine injections had been so good we decided to wait. I was fortunate enough to get Miss Ana M. Rabinovitz, a clever girl student in her last year of medicine, who had already passed her examinations in obstetrics; and installed her in my patient's house December 12. The following day Miss R. brought patient to my office where I carefully examined the thorax radioscopically and took a roentgenogram of the same. Later the plate was sent to specialists who also declared it normal.

Up to this date she had had two attacks more or less the same, both after sleeping quietly for an hour or more, both relieved at once by the same treatment. At midnight again on the 14th she had another attack, which was relieved by the same injection administered by Miss R. When I arrived half an hour later, my patient was still coughing and expelling bloody and frothy liquid, but was better. In another hour she was apparently well. Pulse next morning from 90 to 100 as in health. Temperature 36°C. Blood pressure 85 milligrams mercury. I prescribed 10 drops of digitalin daily for 5 days and on the 21st her blood pressure was 110

with urine normal. Every 4 or 5 days she would have a slight attack relieved at once with one-half centigram of morphine with atropin.

On January 2, 1921, she went to bed early feeling very well but awoke a little after midnight complaining of palpitation. Miss R. gave her at her own request only a quarter centigram of morphine with atropin. On examining her lungs and finding fine râles all through them, with pulse 120 she gave her another quarter, say 5 minutes later. In about 10 minutes she had attacks of coughing with expectoration of liquid as on other occasions, but without the usual relief. In 10 minutes Miss R. gave another half centigram and on my arrival some 20 minutes later 1 centigram. Hot stupes to chest and shoulders which the patient gave us to understand were making her worse, were soon suspended. About 3 a.m. Dr. Day of Mendoza arrived in consultation, and later we tried oxygen and stimulants but without any effect; about 4 o'clock she became unconscious. For hours she had been coughing and expectorating mouthfuls of rose-colored fluid which finally drowned her. From mouth and nostrils this bloody froth continued to flow at each expiration. It was impossible to calculate the amount of liquid as from the first she insisted on using a handkerchief or towel. Judging from the amount expelled in her attack in 1915, it must have been at least 2 litres.

She died at 6 a.m., the heart beating a few minutes after respiration ceased. An autopsy was not allowed. In a similar case I would certainly produce an abortion at 1 or 2 months.

What was the cause of the pulmonary œdema? I believe cramp or spasm of one of the heart cavities.

I will conclude by referring my readers to *The Lancet* 1907, ii, and 1908, i, where they will find a number of articles on this subject; for a novelistic description of the attack and death from this disease to E. Zola's *Fecondite*.

A FURTHER REPORT ON TRAUMATIC FAT NECROSIS OF THE FEMALE BREAST AND ITS DIFFERENTIATION FROM CARCINOMA[1]

Three Additional Cases

By BURTON J. LEE, M.D., F.A.C.S and FRANK E. ADAIR, M.D, New York

In May, 1920, we presented to the American Surgical Association, clinical and pathological data upon the subject of traumatic fat necrosis of the female breast, with two case reports, pointing out the striking similarity of this disease to carcinoma. Since that report, we have encountered in the breast clinic at the Memorial Hospital three additional cases, and these have furnished some new evidence as to the incidence of the disease and its clinical behavior.

A careful search of the literature has revealed not a single reference, outside of our own experience, to this new interesting clinical entity. It has, however, been recognized by Dr. Bloodgood, of Baltimore, who in a verbal report to one of us stated that he had already noticed the lesion upon two occasions. One of his patients was diagnosed as a carcinoma of the breast and a complete radical operation performed. Pathological examination proved the case to be one of traumatic fat necrosis and not carcinoma.

Our former study has made it possible to render a correct pre-operative diagnosis in one of our three recent cases, this particular patient giving a marked simulation to carcinoma. The exactness of the traumatic history in this instance gave us at once a strong suspicion that the case was one of fat necrosis.

The two other patients presented many features suggesting malignancy, but the very sharply defined tumor caused us to render a pre-operative diagnosis of probably benign tumor. Traumatic fat necrosis, therefore, still remains closely allied, in its clinical phases, to carcinoma, but some variation in its behavior may suggest the possibility of a benign process.

We do not hesitate to admit that the clinical diagnosis may be difficult, even though the case may present a distinct traumatic history. The gross pathological picture is characteristic, but requires a pathological training, and the surgeon should have the complete co-operation of the pathologist, in the operating room, as well as in the laboratory, if the patient is to be spared an unnecessary radical amputation.

We are indebted to Dr. James Ewing, pathologist at the Memorial Hospital, for clearly outlining the important features of the gross and microscopical pathology. Our former report contained a full description of the pathological appearances of the disease and the three additional cases have served but to emphasize the characteristic picture therein described.

Concerning the difficulties of pathological diagnosis, Dr. Ewing has pointed out that the microscopic picture may be a difficult one to interpret if the diagnosis by frozen section alone is relied upon. Paraffin sections give a very much clearer microscopic picture.

The complete report of our first two cases has been detailed in a previous publication.[2] The three additional case reports follow:

Case 3. E.S., married, Russian, age 40, was admitted to the Memorial Hospital, June 10, 1920, having been referred to us by Dr. William B. Coley. Patient's chief complaint was tumor of the right breast. The family history was negative for carcinoma. Patient had had four children, all living and well. She had had no miscarriages. She had been operated upon by Dr. Coley, October 27, 1910, for a colloid goiter which showed areas of adenocarcinoma.

Mammary history. Had had four lactations, the first in 1914 and the last in 1917. During 1915 she developed an abscess in the left breast, which had to be incised. At the time of the thyroidectomy 10 years before it had been necessary to give a hypodermoclysis, which was applied beneath the right breast. *No hypodermoclysis had been applied to the left breast.*

[2] Traumatic fat necrosis of the female breast and its differentiation from carcinoma; with a report of two cases. Tr. Am. S. Ass., 1920 xxxviii, 294–313, also Ann. Surg., P., Au. 1920, lxxii, 188–195.

[1] Read before the Surgical Section of the New York Academy of Medicine, October 7, 1921

Fig. 1. Case 1. Traumatic fat necrosis. Gross appearance.

Fig. 2. Case 1. Traumatic fat necrosis. Gross appearance.

Almost four weeks ago a lump was noted in the right breast. It had not increased in size, had not been painful but had caused patient slight worry.

Physical examination revealed a short corpulent woman weighing about 200 pounds. The general physical examination was negative except for scar of thyroid operation. Wassermann was negative.

Breasts. Both breasts were markedly hypertrophied, hanging nearly to the level of the umbilicus. There were wide areas of areolar tissue about the nipples, and numerous dilated veins over the breasts. About 15 centimeters above the right nipple, lying immediately beneath the skin, but not fixed to it, was a tumor that was very hard, nodular, irregular in outline, measuring 8 by 6 centimeters. There was slight fixation to deeper structures. No nipple elevation or retraction were found, nor orange-skin appearance over the tumor. There had been no discharge from the nipple, and no enlargement of axillary or supraclavicular lymph nodes.

Provisional diagnosis: Benign tumor. Malignancy was considered improbable.

Operation was performed July 2, 1920. Ether anæsthesia was used. As it had been considered benign, a local removal of the tumor was made. On section of the excised mass, there were two or three cystic areas with walls very thick and firm, the largest of which measured 2¼ by 2½ centimeters. The contents of the cystic cavities were of a semi-

SUMMARY OF CASES

	Age	Weight	Trauma	Pain	Tumor hardness	Breast corpulent	Nipple retraction	Skin fixation	Deep attachment	Axillary nodes	Supraclavicular nodes	History visible hemorrhage	Patient noted duration	Pre-operative diagnosis
Case 1	52	190	Blow on breast 3 mos.	o	x	x	o	x	x	o	o	o	3 mos.	CA
Case 2	36	211	Hypodermoclysis 7 mos.	o	x	x	o	x	o	x Soft	o	o	7 mos.	CA
Case 3	40	191	Hypodermoclysis 10 yrs.	o	x	x	o	o	x	o	o	o	1 mo.	Benign tumor
Case 4	47	152	Hypodermoclysis 10 mos.	x	x	x	x	x	o	o	o	x	10 mos.	Traum. fat necrosis
Case 5	54	180	Fell 13 steps striking post 8 yrs.	o	x	x	o	x?	o	o	o	x	3 wks.	Fibroadenoma

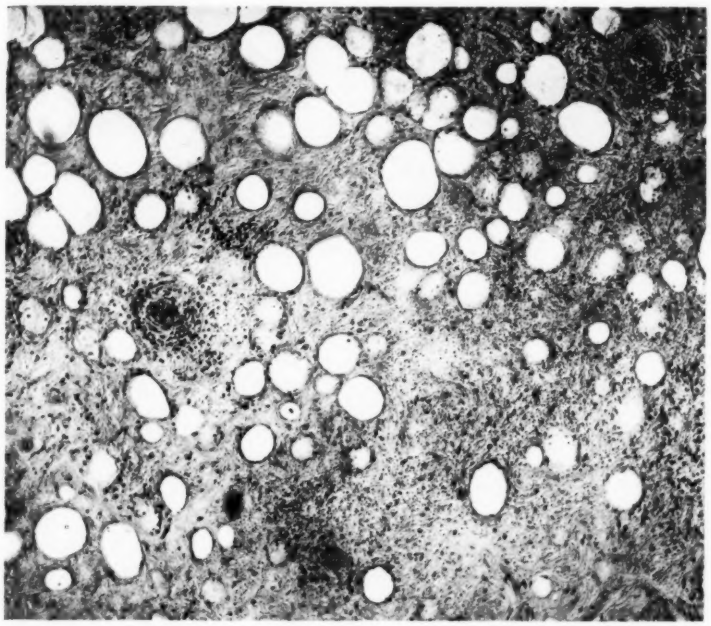


Fig. 3. Case 1. Microscopical appearance, showing endarteritis and peri-arteritis; also fat cells and areas of necrosis.

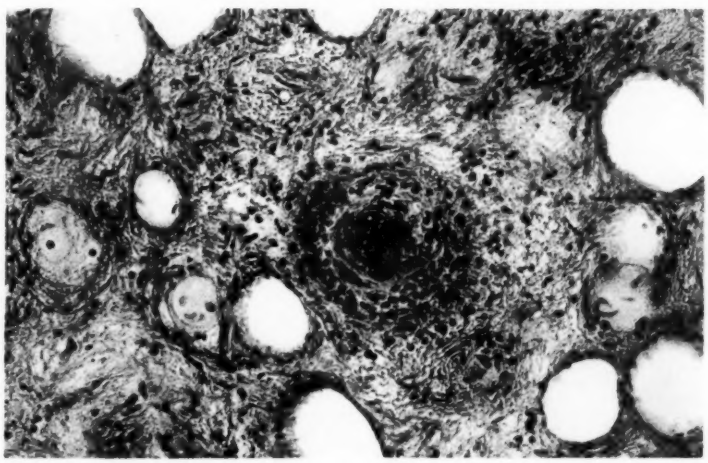


Fig. 4. Case 1. Microscopical appearance, showing enlarged view of Figure 3. This shows fat cells dividing and zone of saponification in many fat cells, also some necrosis.

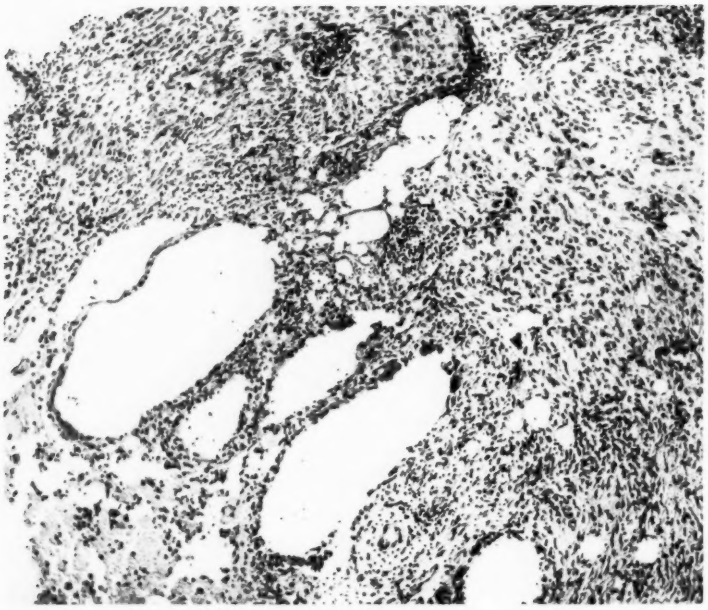


Fig. 5. Case 1. Microscopical appearance, showing productive inflammation and giant cells along tissue spaces containing liquefied fat.

fluid, granular material. The lining of the cyst wall was very irregular, rough, and shaggy, having a chocolate color. It seemed that it might be a degenerated papillary-cyst-adeno-carcinoma. With this diagnosis we proceeded to cauterize the wound edge and then did the radical operation for amputation of the breast.

Pathological report. Gross examination: The breast was very large and very fat. No definite islands of breast tissue could be seen. The excised tumor was 3 centimeters wide and presented a cyst with whitish hyaline capsules 1 millimeter thick. The contents were yellow, granular material, semi-fluid. Outside one-half the periphery of the cyst, the fat tissue appeared necrotic over an irregular area about 1 to 2 centimeters wide. No definite signs of carcinoma were present.

Microscopic examination: Section showed a thick, 2 millimeters laminated, hyaline, connective-tissue wall surrounding the softened cavity which contained necrotic fatty material. The breast tissue about this wall showed active productive inflammation with many round cells about the ducts of the breast, foci of lymphocytes, and new connective tissue. No characteristic signs of lues. No signs of tumor.

Case 4. M. F., married, age 47, was sent by her physician to the Memorial Hospital in October, 1920, "for advice as to radium and X-ray treatments for a breast tumor." Her chief complaint was tumor of the left breast. The family history was negative for cancer. Patient had always been well except for a tumor of the uterus which was operated upon 10 months before admission. Microscopic examination of the tumor had proved it to be a sarcoma.

Mammary history. Had one lactation in 1891 and another in 1895. Hypodermoclysis 10 months ago; otherwise negative.

During January, 1920, 10 months before coming under our observation, the patient was operated on at Atkinson Sanitorium, Jersey City, New Jersey, for what proved to be a malignant growth of the uterus. Due to the patient's condition, a hypodermoclysis was given under the left breast, and this was followed by a black and blue area which persisted for 4 weeks. During this period a hard lump developed in the breast and persisted until the date of admission, diminishing somewhat in size during this period. There were occasional pains and some slight tenderness in and about the left breast. During the 10 months' period radium had been applied three times, her physician taking it for granted that the breast tumor was malignant.

Physical examination revealed a well-developed and well-nourished woman who appeared to be in good health. General physical examination negative.

Breasts. Both breasts were full and adipose, but not pendulous. There was distinct asymmetry, the left breast being less rotund than the right. The left nipple was pulled downward 2 centimeters

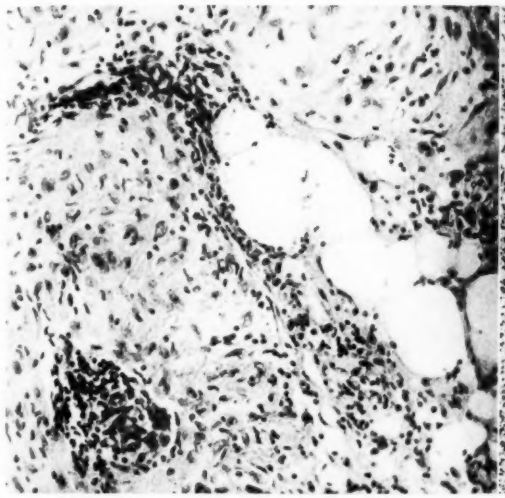


Fig. 6. Case 1. High power picture of Figure 5.

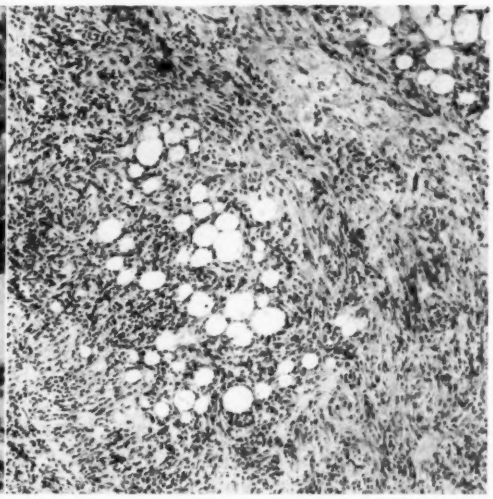


Fig. 7. Case 1. Microscopical appearance, showing productive inflammation about fat cells.

below the level of the right. The left breast showed some "pigskin" appearance, and the veins over it were dilated, while this was not the case over the right. At the junction of the breast and the chest wall, toward 8 o'clock, there was a hard tumor measuring 6 by 4 centimeters showing slight skin adherence, but no attachment to deeper structures. The tumor was movable in breast tissues, nodulated, and so hard that to palpation it gave one the impression of carcinoma. No palpable axillary or supraclavicular nodes.

Provisional diagnosis: traumatic fat necrosis of left breast.

Procedure outlined: (1) X-ray plate of chest; (2) confirm the diagnosis of sarcoma of the uterus by asking the previous operator for a slide or report (in this our effort was futile); (3) cycle of X-ray treatments to breast and its regional areas; (4) photograph; (5) remove tumor under local anæsthesia. Confirm diagnosis, proceed to a radical amputation if the gross examination necessitates it.

Operation October 17, 1920. One-half per cent novocaine anæsthesia. An elliptical incision was made well outside the palpable limits of the tumor and the mass excised. On sectioning the tumor, it was diagnosed as traumatic fat necrosis, and the breast wound was sutured.

Pathological report. An area of breast tissue 4 by 5 centimeters was the seat of chronic productive inflammation with much new fibrous tissue, minute cavities, and streaks of opaque necrotic fat tissue. Section showed new acellular connective tissue; small foci of fluid fat surrounded by giant cells; foci of necrotic or structureless fat, and islands of normal gland tissue.

Case 5. G. R., married, age 54, was sent by her physician to the Memorial Hospital October 6, 1920, for diagnosis of a right breast tumor. The family history was negative for cancer. Patient had never had any serious illness. She has one child alive and well. No miscarriages. No uterine or ovarian disorders.

Mammary history. One lactation 36 years ago with a duration of 9 months, the child nursing both breasts. No history of abscesses or mastitis. No history of hypodermoclysis.

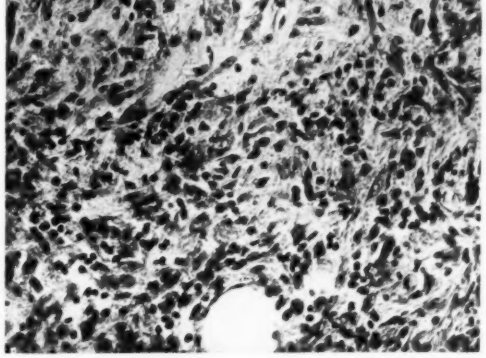


Fig. 8. Case 1. Microscopical appearance. High power picture of tissue in Fig. 7.

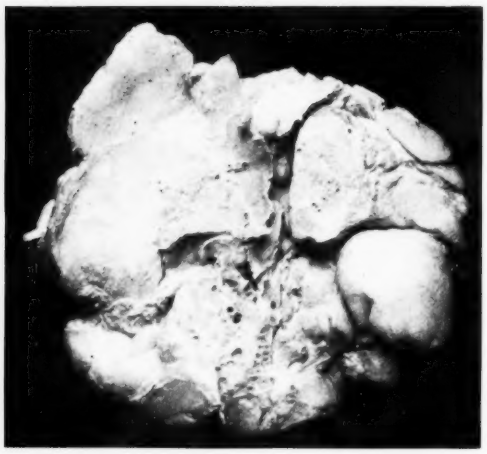


Fig. 9. Case 2. Traumatic fat necrosis. Cross appearance.

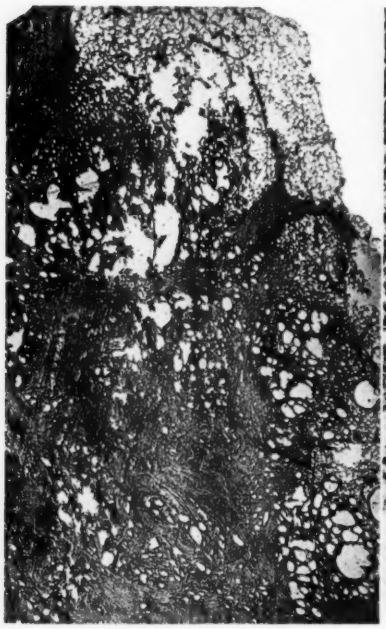
Eight years ago the patient fell 13 steps, striking the upper, inner quadrant of the right breast against the "point of the pedestal." The patient was a short, heavy woman weighing 180 pounds. The trauma was followed by a large area of ecchymosis, which gradually disappeared. Three weeks ago she accidentally noticed the presence of a lump in the upper, inner quadrant of the right breast. She thought that during this period the tumor had not grown appreciably. No pain or sensitiveness was present in the breast at any time.

Physical examination revealed a short, corpulent woman who appeared to enjoy excellent health. Her cheeks were quite red. Blood pressure 180, systolic. Weight 180 pounds. General physical examination negative.

Breasts. Large, full, and slightly pendulous. Left breast negative. In the upper, inner quadrant of the right breast situated 9 centimeters from the nipple toward 2 o'clock, was a firm, smooth, spherical tumor, measuring 2.5 centimeters in diameter. There was a suggestion of skin adherence over it, but no fixation to deeper structures. The tumor was movable in breast tissue. There was no nipple retraction, no "pig skin" appearance, and no discharge from the nipple. No palpable supraclavicular or axillary nodes.

Provisional diagnosis: fibro-adenoma or cyst-adenoma.

Procedure outlined: (1) X-ray plate of chest; (2) photograph; (3) a pre-operative series of five X-ray



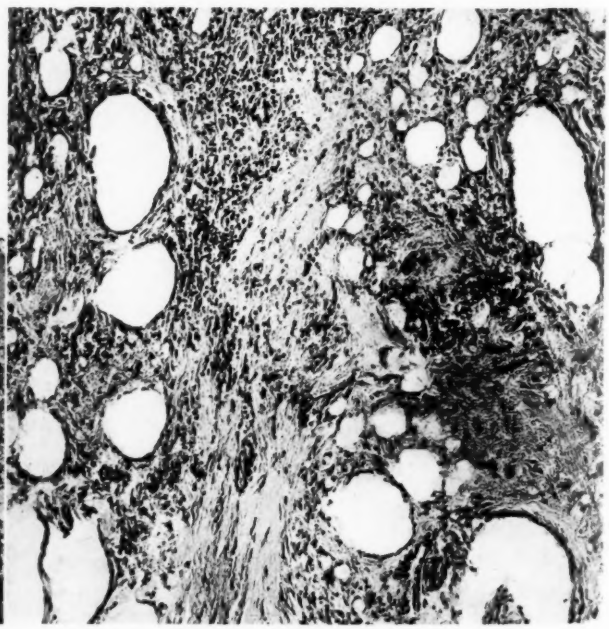


Fig. 10 (at left). Case 2. Microscopical appearance showing new connective-tissue production about spaces containing fluid fat.

Fig. 11. Case 2. Microscopical appearance showing giant cells growing about tissue spaces containing diffluent fat. Also new connective-tissue production.

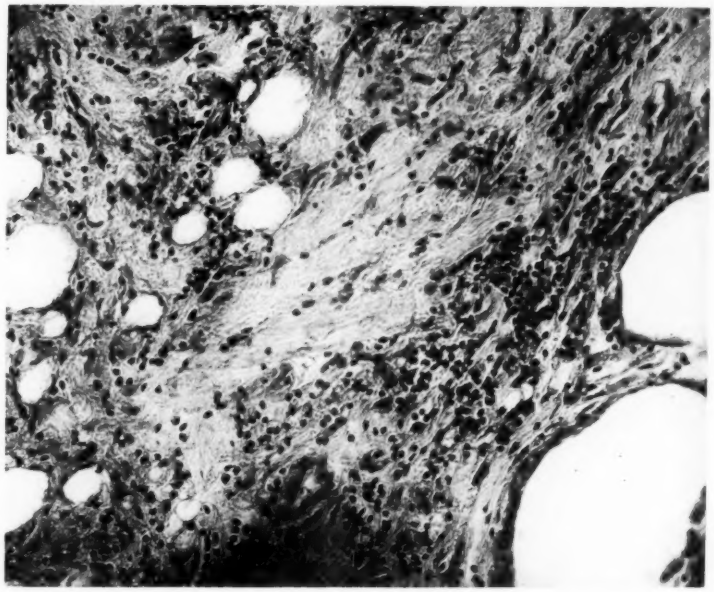


Fig. 12. Case 2. Microscopical appearance. High power of Figure 11.

treatments to be applied over the tumor and breast; (4) local removal of the tumor under novocaine anæsthesia; (5) If necessary a radical amputation, should examination of the excised tumor require it.

Operation. December 11, 1920. One per cent novacaine anæsthesia. Excision of stony tumor 2.5 centimeters in diameter. Examination of the mass showed that the wall of the tumor was 0.75 millimeters in thickness and appeared to be calcified, while the cut section was of unusual appearance and hardness. In the center of the tumor was a small cyst 1 centimeter in diameter, containing a dirty, yellowish-brown, thick, fluid. Positive appearances of carcinoma were lacking, so nothing further was done at operation. Suture of breast wound.

Pathological report. Section showed chronic productive inflammation in fat tissue. There was a small central cavity filled with semi-fluid, fatty material, about which were many similar small cavities around which giant cells were forming.

INCIDENCE

During the period in which these patients have presented themselves at the breast clinic, we have also encountered 120 cases of primary operable and 163 of primary inoperable breast carcinomata. Traumatic fat necrosis of the breast, in comparison with primary breast carcinomata has occurred in the proportion of 5 to 283, or 1.8 per cent. The occurrence of fat necrosis in comparison to primary operable carcinomata is as 5 to 120, or 4.2 per cent. Among our benign breast tumors the proportion of fat necrosis to other benign lesions is as 5 to 72, or approximately 7 per cent. Cases of fat necrosis, therefore, are not rare.

AGE

All examples of the disease have occurred at the age when cancer was to be expected. The youngest patient was 36, the oldest 54.

CORPULENCY

This seems to be an important factor. In this series there was not one thin individual and every patient had more than the average amount of subcutaneous tissue. All were heavy women, none weighing under 152 pounds, while the most corpulent weighed 211 pounds. The disease, therefore, apparently occurs in patients whose subcutaneous fat deposits are above the average.

CORPULENT BREASTS

In every instance the breasts were large and full. In one individual the mammary glands reached to the level of the umbilicus.

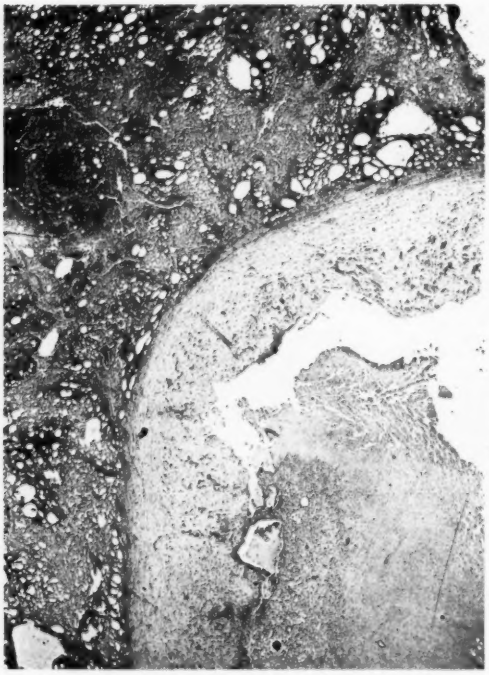
Fig. 13. Case 3. Traumatic fat necrosis right breast. Note corpulency.

Fig. 14. Case 3. Traumatic fat necrosis. Gross lesion. Outer areas inflammatory fat tissue. Very firm wall. Necrotic center roughened and papillary in areas

TRAUMA

One of the chief diagnostic points is a *bona fide*, accurate history of trauma. Great care should be taken by the surgeon to assure himself that the site of injury coincides with the location of the fat necrosis. Unfortunately, although a history of trauma is too easily obtainable from patients suffering with breast carcinoma, it is frequently indefinite and inaccurate.

Case 1 received a severe blow upon the breast delivered by the sharp point of an elbow.



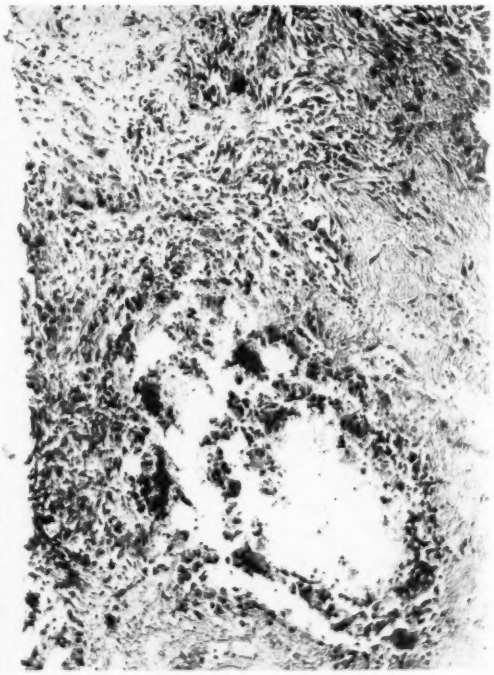


Fig. 15 (at left). Case 3. Microscopical appearance, showing much necrosis; also spaces of liquefied fat.
Fig. 16. Case 3. Microscopical appearance, showing necrosis, large spaces containing fat fluid, giant cells and new connective tissue.

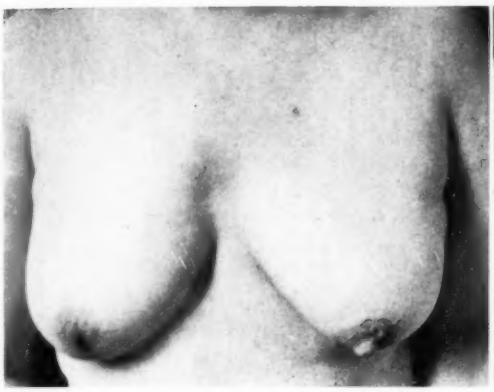


Fig. 17 Case 4. Traumatic fat necrosis left breast. Note asymetry at lower inner quadrant of left breast.

Fig. 18. Case 4. Same as Figure 17, showing skin attachment.

Case 5, a woman weighing 180 pounds, suffered a definite trauma to the breast by falling 13 steps striking against a sharp corner of a post.

In three of our cases hypodermoclysis was a traumatic factor. This has led us always to suspect a lesion of fat necrosis where hypodermoclysis has been administered previously.

ECCHYMOSIS FOLLOWING TRAUMA

In two cases a definite ecchymosis followed the receipt of the trauma. Such a history may be a valuable guide in establishing a diagnosis of fat necrosis.

LACK OF PAIN

Four of the patients suffered not the slightest pain in or about the breast. One (Case 4) complained of a slight transient pain at irregular intervals, but the symptom was not a marked factor.

CONSISTENCY

A characteristic symptom of traumatic fat necrosis is the extreme hardness of the tumor. Every one of the five cases showed a consistence sufficiently hard to lead one toward the diagnosis of a malignant tumor.

NIPPLE RETRACTION

This symptom was obtained in but one instance and therefore may be regarded as an inconstant physical sign.

SKIN FIXATION

In all save one, definite fixation of the tumor mass to the overlying skin was readily elicited, and this should, therefore, be considered a fairly constant symptom of fat necrosis. This sign may strongly suggest a diagnosis of carcinoma.

DEEP ATTACHMENT

This was observed in two instances, but was lacking in the three other patients and cannot be regarded, therefore, as a constant symptom.

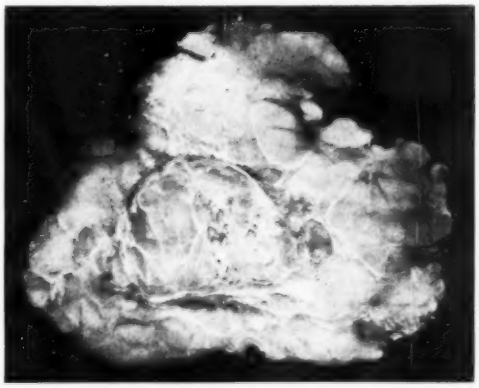


Fig. 19. Case 4. Traumatic fat necrosis. Gross lesion, showing fat lobules, areas of fibrosis, and necrosis.

Fig. 20. Case 4. Microscopical appearance. Large tissue spaces containing fluid fat, some necrosis, and new connective tissue.

Fig. 21. Case 5. Traumatic fat necrosis right breast. Photograph taken a few days postoperative. Note heavy type of breast.

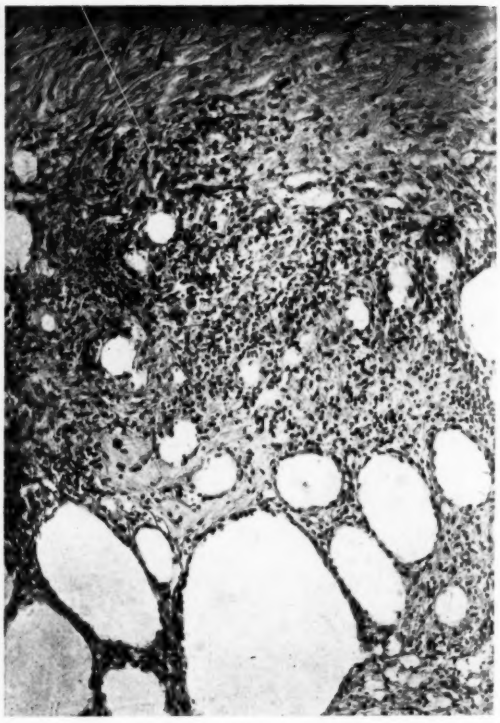


Fig. 23. Case 5. Microscopical appearance. Large tissue spaces with some areas of necrotic fat and new connective tissue.

NODES

In all of the patients, except one, no axillary or supraclavicular nodes were to be palpated, and in this single case the nodes encountered were exceedingly soft and gave no suspicion of malignancy. The absence, therefore, of any definite node involvement may furnish a differential point between fat necrosis and carcinoma.

DURATION

a. From the receipt of the trauma to the recognition of the tumor: There seems to be no constancy in this time factor, as in the series under report there was a variation from 3 weeks to 10 years.

Fig. 22. Case 5. Traumatic fat necrosis. Gross lesion, showing fat lobules, inflammatory zone, very firm wall, necrotic center containing liquefied fat, and small pieces of calcified tissue.

b. From the recognition of the tumor to the beginning of treatment: This period varied from 3 weeks to 10 months, so that here again no definite rule can be laid down.

In our former communication a rapid increase in the size of the tumor was noted. In the three additional cases now being reported no such history was obtainable and we, therefore, believe that rather less stress should be placed upon this symptom as a diagnostic aid.

CONCLUSION

The present study furnishes important additional evidence that traumatic fat necrosis of the female breast is a disease not infrequently encountered, and one which must always be carefully differentiated from carcinoma.

We beg to express the hope that this report may stimulate surgeons and pathologists to a more careful scrutiny of the gross and microscopical pathology of all tumors of the breast in the belief that a thorough search for evidence will reveal many cases of this disease hitherto unrecognized.

We desire also to suggest the possibility that some cases which in the past may have been diagnosed by the gross picture alone as carcinoma of the breast may not have been cancerous in their nature at all, but perhaps true examples of traumatic fat necrosis.

DEPARTMENT OF TECHNIQUE

SOME NOTES ON PLASTIC OPERATIONS[1]

BY LEO ELOESSER, M.D., SAN FRANCISCO
Associate Clinical Professor of Surgery, Stanford University Medical School

THERE are two ways in which to replace a missing part of the body: one may use material from the neighborhood, if one can get it; or, if none is to be had, one may bring material from a distance.

In the first method the material is swung over to the defect on a stalk, and the stalk is retained as in Figures 1 and 2; the flap keeps its original blood supply, which runs through the pedicle. In the second method, when material cannot be had from nearby and must be got from a distance, it is necessary to uproot it, to lift it out bodily from its surroundings and transplant it to its new bed.

It is clear that the first method is the one of choice; not only is it more likely to be immediately successful, but it fills the gap with a tissue ultimately and always hardier. A flap that continues to be nourished through a pedicle is, of course, less risky than a free graft. There is always some risk that a free graft may die before the nutrient juices from its new bed have a chance to reach it. This immediate risk, however, is not the main objection to the free graft. The chances of life and death for the various kinds of grafts have been worked out pretty reliably, so that we know, for instance, that a Thiersch graft done under certain conditions will succeed, and that a Wolfe-Krause graft done under other conditions will not. This immediate risk is not the main objection—we can circumvent it, if a sudden uprooting seems too dangerous, by making a gradual transplantation, an Italian plastic (as in Fig. 5). The Italian plastic combines the first and second methods. It uses a pedicled flap at first, which it attaches to its new bed. It ends with a free graft. For, at the moment when the pedicle is severed, the transferred tissue *is* a free graft; it retains no connection with its old bed.

The main objections to the free graft lie not in its immediate results but in its ultimate outcome, and these objections hold whether we do our graft as a free graft at one sitting, or at several as an Italian plastic. The objections to the graft, the reasons why it is less likely than the flap ultimately to succeed are these: The graft always remains an island entirely surrounded by scar. The scar never disappears. Elastic fibers that grow through it are never normal; lymph vessels never pierce it. Blood vessels and nerves may in time pervade it, but it is a question whether they ever become entirely normal blood vessels and nerves. And so the graft island never comes entirely to resemble the tissue which it was intended to replace, nor even the neighboring tissue into which it was implanted. The scar barrier always remains. The tissue island always has a tendency to turn blue, especially when it is exposed to cold; it always has a tendency to become œdematous. It withstands but feebly infection and ordinary small injuries—pressure and bruises.

The flap, even if it has but a slender stalk through which its original blood vessels, nerves, and, above all, its original lymph vessels run, is preferable in the end to the island left by the free graft.

The only reason for resorting to free grafts at all is that they offer a source of practically unlimited supply, and that the material, being entirely separated from its old bed, may be twisted, shaped, and turned at will to fit its new one. A device then should be a good one that will enlarge the area from which a pedicled flap may be swung and that will make the pedicle freer, more easily turned, and twisted. This device is the semidetached flap.

THE SEMIDETACHED FLAP

The semidetached flap lies but a step from the flaps emphasized by Esser. Esser, a Hollander, who has published several articles in American journals[2], planned his beautiful facial flaps with the idea of having the main facial arteries run undisturbed through their stalks. Thus he laid his pedicles on the cheek so as to include the external maxillary vessels; in the nasolabial fold so as to include the angularis; or on the side of the

[2]Ann. Surg., 1917, lxv, 297.

[1]From the Division of Surgery, Medical Department, Stanford University. Read before the Medical Society of the State of California, Coronado, May, 1921.

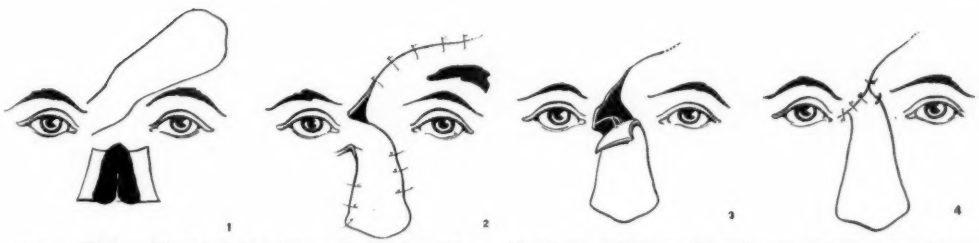


Fig. 1. The semidetached flap for nasal plastics. The flap outlined.

Fig. 2. The semidetached flap for nasal plastics. The flap turned down.

Fig. 3. The semidetached flap for nasal plastics. The skin of the pedicle cut through. The subcutaneous tissue, carrying the dorsalis nasi artery, remains intact. The flap retains a normal vascular connection.

Fig. 4. The semidetached flap for nasal plastics. Skin of pedicle stitched into place.

head so as to include the temporal. These large vessels flowing through even slender pedicles assured the nutritions of his flaps.

Esser, however, as far as I can find out, preserved not only the vessels in the stalks of his flaps, but left an attachment of skin. To leave the skin attached is, it seems to me, not always necessary. The skin in the pedicle hampers movement of the flap. It not only lessens the distance over which it may be pulled or stretched, but it lessens the arc through which it may be turned, or bent, or twisted.

Can we not entirely circumcise the skin if we leave intact a stalk of subcutaneous fat and connective tissue, with good blood vessels in it? This method will give the flap a greater range of motion; not only a greater range, but greater freedom. The blood vessels are more yielding than the skin, and may be turned through a greater angle without buckling or puckering. Even though the skin be cut all around, the flap is not detached so long as it carries an intact stalk of blood vessels running into it from underneath. It is not a free graft; it is not an island entirely surrounded by scar; it will not become blue and œdematous on slight provocation, for it keeps its original blood and lymph vessels that come from its original bed.

The semidetached flap is most useful in nasal plastics. The main objection to noses made from skin of the arm by the Italian method is that they tend to become blue and œdematous on exposure to cold. The same objection holds for noses made by a pedicled flap from the skin of the forehead, if the pedicle is cut in the later stages of the operation. Severing the pedicle turns the pedicled flap into a free graft. If, however, we bring the pedicle from the inner canthus of the eye, and preserve the frontal artery and the dorsalis nasi throughout all stages of the plastic, the new nose will always be nourished by a normal vessel. One may, in the final stages of the operation, sever the skin of the pedicle and transfer it to the glabella if one does not cut too deeply and leaves the artery uninjured in the flap. A nose made by this semidetached flap, which retains a stalk of normal blood vessels, will not become blue or œdematous. It will keep its vasomotor tone, and the blush will return to a spot made anæmic by pressure, as it does in normal skin.

THE STALK CARRIES MORE BLOOD THAN THE SCAR

The quantity of blood that a very slender stalk will carry is astonishing. The vessels in it meet the overload that is put upon them when they are called upon to carry the blood to a large flap with a surprisingly rapid dilatation. If one detaches the pedicle of an Italian flap at several sittings, and narrows the pedicle with incisions made a few days apart, the first incisions seem to lessen the blood supply of the flap very little. The flaps grow neither pale nor cyanotic. When, however, the stalk is very slender (a centimeter or so across) and is finally severed, it spurts most vigorously from large vessels. And if this last detaching stroke is made too early, say 2 weeks after the first operation, the flap may become necrotic even though the pedicle that nourishes it be no more than a centimeter across. The length of the line of union between the flap and the edges of the defect may measure many times the width of the pedicle, and yet it is the stopping of the blood supply through this last bit that turns the flap blue and necrotic. Even when the pedicle is severed at the proper time, when the circulation through the scar is sufficient, one will see, if one watches the flap, that it turns blue and cold the moment the pedicle is severed, and then gradually recovers in the course of half an hour or so. This observation shows that more blood runs through the natural vessels in the last centi-

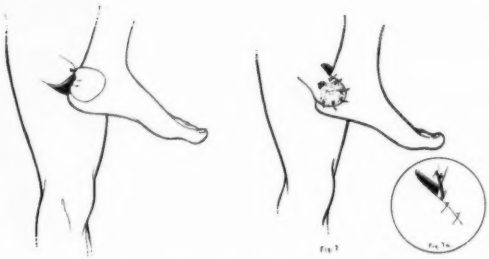


Fig. 5 (at left). Italian plastic. The pedicle has been incised in several stages. It is ready for final severance. A rubber band is tied around it to test the viability of the flap before cutting it entirely through. The defect made by the flap, shown in black, has been covered by a Thiersch graft.

Fig. 7. A poor flap for an Italian plastic. The pedicle is too long. It is held in apposition by a mattress stitch over rubber tubing which will afterward cause the shaded area to slough. Insert shows a properly placed tension suture. A strong suture brings together the edge of the defect left by the flap and the edge of the defect which is to be covered.

meter of pedicle than through the newly formed vessels in the fresh scar, however long it may be.

TECHNIQUE OF THE ITALIAN PLASTIC

In order to lessen the danger of necrosis, one should sew the free edge of the flap accurately to the freshened edge of the defect. Hard and inflamed skin edges should be cut away, even though it be necessary to enlarge the defect. The suture should be made in sound skin; an infection in the suture line will greatly impair the vitality of the flap. The sutures should be of horsehair and should be just tight enough to bring the edges nicely together. Tight stitches make the tissue they include anæmic. Not only should the skin

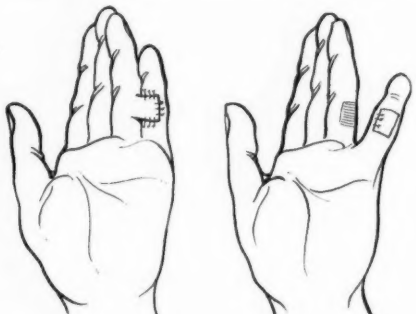


Fig. 8. A small Italian plastic for covering the defect after removal of a flexion contracture of a finger. The flap is taken from the side of one finger and led to the palmar surface of a neighboring one. Its bed is covered by a Thiersch graft done at the first stage of the operation.

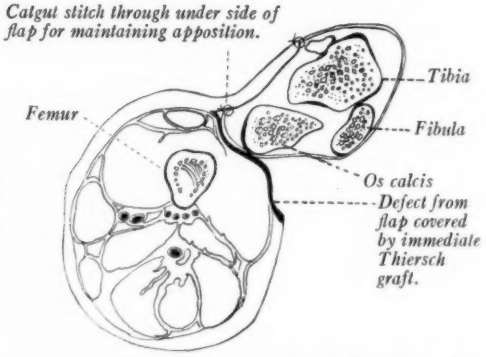


Fig. 6. Italian plastic from thigh to heel in cross section. First stage. The flap has a short bridge. It is held in apposition by a fine catgut stitch through its under surface. The wound in the thigh has been covered by a Thiersch graft.

edges be brought together accurately, but the raw under surface of the flap should be kept in broad and steady apposition to the base of the defect so that new blood vessels can grow into it from underneath.

If the flap will not stay in apposition by itself, it may be fastened to the defect by one or two fine No. oo catgut stitches passed through the defect and the under surface of the flap (Fig. 6). It should never be pulled over on to the defect by a mattress stitch or by any other stitch that makes tension on the pedicle. A slight tension anæmia in the stalk will make a much greater area of anæmia in the body of the flap. The anæmic zone will spread out into the flap like a fan, the tip lying at the pedicle (Fig. 7). A mattress stitch through the pedicle will make a large slough around the stitch itself. Often the whole flap will slough. If tension sutures are unavoidable they should pass, not through the body of the flap nor through its base, but through the skin at each side of the base to the skin at the side of the defect. One may pull such stitches as tight as one likes without harming the nutrition of the flap. Indeed, if the flap is under tension, pulling it over toward its bed by sutures placed at each side will make it more slack and improve, not decrease, its circulation (Fig. 7a).

The free bridge leading from the base of the flap to the first point of attachment to its new bed should be just as short as is possible without putting the flap under tension. A long free bridge dangling between the base and the new bed is liable to infection and is wasteful of tissues. The bridge may be made short by sewing the sides of the flap well onto the defect, although these side

sutures are hard to place as they approach the base of the flap. The flap should be taken from a part of the body which will lie snugly and easily against the free edge of the defect, so that there need be no long free bridge.

In doing an Italian plastic it is a mistake not to give strict attention to asepsis. It is true that there will be some postoperative infection of the raw surfaces, that the patient will sweat and otherwise contaminate his wounds, and that the dressings will be more or less inaccessible and hard to keep clean. But the more carefully the patient is cleaned and shaved before the operation, the less infection will there be afterward.

The best way to limit an infection is to make the raw surfaces as small as possible. The edges of the wound left in the sound skin from which the flap was taken should be brought together by sutures. These stitches may be pulled very tight. If they are properly placed, they will decrease and not increase tension on the pedicle. If the skin cannot be brought together, and it is necessary to cover part of the wound with a Thiersch graft, the Thiersch graft should be applied immediately and not at a later stage. The immediate Thiersch graft not only saves time, for it heals the wound left by the flap by the time the pedicle is severed, but it decreases the raw surface open to infection. The immediate Thiersch graft takes well, even though they may have to bear the weight of the grafted extremity if it lies upon them. They are usually perfectly immobilized by the apparatus that holds the two grafted parts of the body together.

Infection damages the Italian plastic more than any other factor. A severe infection will kill the whole flap; but even a mild one, that the flap can overcome, will leave it boggy and thick, and make an ugly scar. A small stitch abscess will leave an obstinate and torpid ulcer once the pedicle is severed and the blood supply of the graft impoverished. The amount and severity of infection determine the time for cutting away the pedicle.

WHEN TO SEVER THE PEDICLE

When to sever the pedicle is the nicest question in the performance of the Italian plastic. One is between two fires. The longer the flap remains attached, the greater the scar, shrinkage, and infection; the sooner it is cut off, the greater the risk of necrosis. To balance properly the time between the two evils calls for delicate judgment.

The following plan has helped us to decide. We make an ample broad pedicle, and cut it through in several sittings. The first incisions

Fig. 9. The bridge flap. First stage. A bridge of skin, has been made between two parallel incisions, undermined, lifted from its bed, and stitched back into place.

into the pedicle are made early, about 10 days after beginning the plastic. They sever perhaps half or two-thirds of the pedicle, and are immediately stitched with a few horsehair sutures to the edges of the defect. Three or four days later a little more of the pedicle is cut. During the third week the blood supply of the flap is watched. One presses on it with the finger and sees how soon the blush returns to an anæmic spot. When it seems safe, usually after about 3 weeks, the test is made for final severance. A thin elastic band is tied around the pedicle. It need not be tied tightly. A very little pressure is enough to occlude the arteries. The flap is watched for 20 minutes or so. It turns blue and dusky when the band is tied—almost always. This blueness is probably due to a reflex cramp of the vessels. If the blueness disappears in 15 or 20 minutes, the flap is safe, and one may cut the pedicle immediately, or leave the band and cut the pedicle the next day (Fig. 5). If, however, the flap stays blue and dusky, one releases the band and waits a few days longer. By applying and releasing the band every few hours, one might perhaps stimulate the new circulation through the scar.

The patient should not be too uncomfortable in his retention apparatus. The bed of the graft and the place from which the graft is taken should lie together naturally. It is hard enough for the patient to lie immobile for 3 weeks, but to have his limbs forced into a strained position and kept there for this length of time is almost intolerable.

THE FLAPS

The flaps should not include too much subcutaneous fat. They tend to swell and to become boggy anyway. The skin of the flap should resemble, as nearly as possible, the skin of the neighborhood to which it is transferred. For a transfer to the hand or forearm, the other forearm is better than the belly or chest, and it is easier to hold the two forearms together than it is to fasten the hand to the chest or to the belly.

FINGER FLAPS

For flexion contractures of the fingers, the flap may be taken from the side of a neighboring finger. This gives a very pretty result and very little inconvenience—merely the tying together of two fingers. The scar on the volar side of the finger is excised. A flap is cut from the side of a neighboring finger, with its base toward the palm, and is stitched over the defect. The wound left by the flap is covered with a Thiersch graft. The base of the flap is cut in two or three stages, and the flap is finally severed after about 3 weeks (Fig. 8).

If a hand or foot is badly mangled and crushed so that some of the fingers or toes need amputation, a deal of patching and salvage may be done by turning the skin from the fingers that are to be cut off on to the back or the palm of the hand, or by leading it from one finger to another.

BRIDGE FLAPS

The principle of the gradual severing of flaps may be used in parts of the body with poor circulation, such as the leg, or where the flaps are to be made very long. A bridge flap is very much better nourished than a single pedicled flap. It may be made much more than twice as long as a flap with a single pedicle. It is first outlined by two parallel incisions and is undermined from one side to the other. The flap is left in place and the incisions are immediately closed with horsehair sutures (Fig. 9). After a week or ten days the incisions at the tip of the flap are united by a cross incision, which is again immediately closed. This outlines a pedicled flap which, however, is left in its original bed. After another week or ten days a fresh incision is made just to the inside of the original ones and the flap is swung into its final position. If the flap be planned as an Italian plastic, the pedicle is severed after 2 or 3 weeks and the plastic is complete.

TRANSPLANTATION OF STENSON'S DUCT FOR RELIEF OF DROOLING

A few words on an operation for the relief of drooling, which I have not seen described. The operation was performed upon the patient whose picture is shown to illustrate the bridge flap. A large recurrent cancer of the lower lip and jaw had been removed. It was necessary to remove the chin and more than two-thirds of the whole jaw. In order to finish the extensive operation quickly, the enormous gap was filled by sewing the tongue into it. A new lower lip and a buccolingual fold were reconstructed later. As the jaw had been removed up to the third molar on the right side, Stenson's duct debouched not more than 1 centimeter from the edge of the new lower lip. The mouth could not be closed tightly, so that the poor man was made wretched by his drooling. His shirt and waistcoat were continually wet with saliva. He re-entered the hospital and begged for relief. So much of the cheek and neck was gone that there was no material for perfecting the lower lip. An Italian plastic would have been too much for this old man to stand. The drooling came from the right stenonian duct. Both submaxillary salivary glands had been removed. It seemed to me, therefore, that if the opening of the parotid duct could be laid farther back toward the pharynx, the saliva might run down his throat instead of dribbling from his half-open mouth.

A transverse incision was made in the cheek and the duct, which was about 1½ inches long, was dissected from the front edge of the parotid to the papilla. The papilla was cut out from the oral mucosa, and a catgut stitch was passed through it. A small stab wound was made through the rear edge of the masseter into the back of the mouth near the pharynx, and the catgut stitch to which the parotid duct was fastened, was passed through it into the mouth. By pulling on the stitch the parotid duct was made to follow. A half inch or so of it was left dangling into the rear of the mouth near the pharynx. The man's drooling was greatly lessened, but not entirely stopped, by this operation. Some saliva still ran, I suppose, from the sublingual or other smaller salivary glands. The duct was transplanted in a second patient operated upon for cancer of the lip and cheek. This transplantation was done as a primary procedure, forming a step in the plastic

closure of the wound. The operation was easy, and might be worth considering in men whose lips cannot be closed, and the fronts of whose mouths have been destroyed.

SUMMARY

1. A graft of the whole thickness of skin, whether done at one sitting as a Wolfe-Krause graft, or at several, as an Italian plastic, always remains an island surrounded by scar.

2. It turns blue on exposure to cold and is little resistant to infection or trauma.

3. A pedicled flap which retains the normal vascular connections does not have these disadvantages.

4. A procedure is described for making a semi-detached flap, severing the skin of the pedicle but retaining its vessels. Such a flap has much of the freedom of a free graft but does not have its disadvantages.

5. More blood runs through the pedicle of an Italian plastic flap than through the line of union with its new bed, no matter how narrow the pedicle, or how long the line of union.

6. The vascularity of the pedicle should not be damaged by mattress or tension sutures.

7. Infection should be limited by covering the defect left by an Italian flap with an immediate Thiersch graft.

8. The viability of the flap is determined by temporarily occluding the pedicle with a rubber band before finally severing it.

9. The defect, after excision of a flexion contracture of a finger, may be covered by a flap from a neighboring finger.

10. Drooling may be relieved by transplanting Stenson's duct backward.

DEMONSTRATION OF BLADDER DIVERTICULA

By HERMAN L. KRETSCHMER, M.D., F.A.C.S., Chicago

As a rule, diverticula of the bladder are discovered during cystoscopic examinations. Cystoscopic examination gives information regarding the number and location of the diverticula but it fails to give us any information regarding their size or capacity. Failure to obtain this information is one of the limitations of cystoscopy in cases of this type.

Fig. 1. Roentgenogram of injected diverticula.

Cystography is used as an aid to cystoscopy in demonstrating the size and extent of the diverticula. Occasionally cystography fails to give the desired information because of the position of the diverticulum.

The passage of shadowgraph catheters into the diverticulum has been resorted to at various times and this may be followed by an injection of the diverticulum, through the ureteral catheter, with one of the usual opaque media which are used for this purpose. This method gives more accurate information than either of the two previously mentioned methods, and has been reported by various authors.

In order to define more clearly the extent of the diverticulum, we have combined the latter method with air cystography. After the diverticulum is injected, the bladder is filled with air. This procedure is an aid in producing a much sharper definition, a fact evident after an examination of the two plates.

Fig. 2. Roentgenogram of the injected diverticula after filling the bladder with air.

OPERATING CYSTOSCOPE IN APPLICATION OF RADIUM TO CANCER OF THE RECTUM FOLLOWING COLOSTOMY

By JOHN O. BOWER, M.D., F.A.C.S., Philadelphia
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IN malignancy involving the bladder or rectum, direct application or implantation of radium into the growth has been fairly successful. Undoubtedly, better results are obtained, however, when these growths are subjected to cross fire.

In the bladder this may be accomplished if the growth is situated on the anterior wall by applying radium directly against it, using an applicator or by the use of a hollow metal sound, crossfire being obtained by imbedding radium needles near or into the base of the growth through a suprapubic incision; if the growth involves the base, an efficient crossfire may be obtained by using a special applicator through the cystoscope in conjunction with a hard rubber applicator in the rectum.

A number of instruments have been devised for intravesical application, and crossfire, employing the methods mentioned, is not new. I wish, however, to report a method of treatment of cancer of the rectum using the operating cystoscope. Three cases of cancer of the rectum have come under my observation recently, in all of which an operating cystoscope and a specially devised applicator have been used to great advantage in implanting radium in the proximal portion of the growth, an effective crossfire being obtained by inserting radium, properly screened, against the growth through the anus.

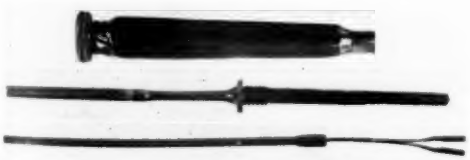

Fig. 1. Radium needle applicator.

TECHNIQUE

a. A lower left rectus or inguinal colostomy is done under local or spinal anæsthesia, and the bowel is opened on the third or fourth day by the use of the thermocautery.

b. On the seventh or eighth day, the lower segment is flushed clear of all débris, using a 25 F. catheter attached to a 1000 cubic centimeter reservoir; when the fluid returns clear, the cystoscope with irrigating tube attached is inserted into the bowel, the obturator is withdrawn, the telescope is inserted and the special instrument holding the radium needle is introduced into the cystoscope, and the radium needle with silk cord attached is imbedded into the growth. The instrument is then withdrawn and as many needles as required introduced. The free ends of the braided silk are caught with a hæmostat or fastened with adhesive tape to the patient's abdomen.

Fig. 2. Operating cystoscope and applicator with radium needle attached.

c. Then using a hard or soft rubber applicator, radium, properly screened, is inserted against the lower portion of the growth through the anus.

The advantage of this method of crossfire is maximum radiation due to accurate placing.

THE TREATMENT OF CONGENITAL HALLUX VARUS

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THE textbooks give very little information regarding hallux varus, and, indeed, most of them infer that the condition is merely part of the deformity in talipes varus. In the common variety of talipes equinovarus it is true that the varus element frequently persists as the well-known pigeon toe, but it arises from deformity of the tarsus, while in the malformation under discussion the defect is confined to the great toe. Were the deviation of the pigeon toe due to defect in the phalanx, its cure might rightly be left to be effected by the modern boot. The similarity of the two cases is so close that the malformation would appear to be stereotyped.

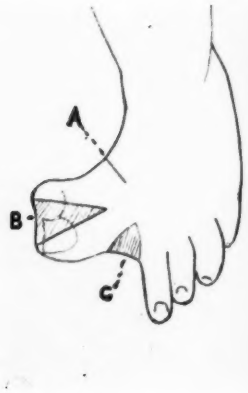

Fig. 1.

Fig. 2.

Fig. 3.

Fig. 1. Schematic drawing showing incision, graft, and wedge.
Fig. 2. Cast of Case 1, before operation.
Fig. 3. Case 1, Result of operation.

Fig. 4(at left). Case 2, before operation.
Fig. 5. Case 2, after operation.

The toes were double, fused, and were placed at right angles to the long axis of the foot. The malformation would appear to be stereotyped. The X-ray plate showed the metatarsal bone to be normal. Both cases were brought to the Hospital in 1920, within four months of each other.

The procedures adopted to correct the deformity may be summarized as follows:

1. The structures on the proximal side were divided by open incision at right angles to the axis of the toe (Fig. 1, incision).

2. The toe is then forced into alignment with the other toes, causing the formation of a wide raw surface on the inner side of the metatarso-phalangeal joint.

3. A skin graft is required to fill in this gap and it is exactly formed by the redundant tissue requiring to be excised from the web between the great and second toes (Fig. 1, graft).

4. Retentive apparatus (plaster-of-Paris) is required after the operation but it is useless before.

5. The duplicity of the toe itself requires primary treatment. Removal of the innermost

toe would result in a cicatrix strong enough to excite a recurrence of the deformity. To prevent such an action, a scar should not be located along the inner border of the toe but a wedge should be removed from the tissue of the fused toes, each being taxed one half (Fig. 1, wedge).

This procedure is that commonly carried out for the building up of a single, in place of a bifurcated, digit.

The accompanying photographs show the condition before operation and the results obtained in Cases 1 and 2.

AMPUTATION STUMPS AND THEIR ADAPTATION TO ARTIFICIAL LIMBS

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FOR about 1 year, while making orthopedic examinations for the Public Health Service, the writer had the opportunity of observing a large percentage of the amputation cases in New England that resulted from the late war. The comparison of these cases with the end-results of civilian amputations seen in general hospital and private practice forms the basis for this article.

Practically all ex-service men having amputations had been kept as patients in their respective service hospitals until they were able to walk with an artificial limb. They were instructed to wear these temporary artificial limbs for at least 6 months, to have them adjusted as necessary during this time, and at the end of this period to apply for permanent limbs.

After being discharged from army or navy hospitals, these patients were referred to the Public Health Service for further treatment or prosthesis as necessary. When first seen, these men called to have their temporary limbs repaired, to apply for permanent artificial limbs, or to have some stump affection cared for which prohibited the wearing of the temporary or permanent artificial limb.

The operative results were very satisfactory. Flexion deformities were extremely rare, and the range of motion in the joint just above the amputation site was usually unrestricted. A small percentage had tender scars from neuromata, and there were several that had discharging sinuses from osteomyelitic processes. Tender scars were resected and sinuses healed before such cases were referred for permanent artificial limbs.

It was rare to run across a man who had been operated on but once. Nearly all had had two or more amputations, the reason commonly being that infection was originally present; others had to be re-operated upon owing to an unsatisfactory amputation site having been selected, and for no other reason.

The outstanding feature about these cases was that they were treated through to the actual walking stage. How different was the story related by several limb makers who were interviewed. They stated that in civil practice most of their cases were referred by others similarly maimed; very few were referred directly by the surgeon; of those that were so referred very few were still under the surgeon's observation. But more than this, they stated that in many instances in selecting the amputation site the surgeon apparently gave no thought to the future usefulness of the stump. Owing to a lack of interest on the part of the surgeon in the interval between the operation and the fitting of the limb, many patients reported with deformities, such as flexion contraction, which could have been prevented and which seriously interfered with obtaining maximum service from the prosthetic appliance. In other words, lack of co-operation between the limb maker and surgeon frequently caused bad results which were preventable.

As a result of the observations made in the course of examining these patients, together with the information obtained from limb makers, with whom the writer has been in close touch, the following suggestions seem warranted.

THE STUMP

In general we want an amputation stump that will be covered with just enough skin and muscle so that the slack will be freely movable over the end, and yet not redundant. There should be an entire absence of sharp corners, pain, or tenderness, and the scar should be linear, non-adherent, and posterior to the end of the bone. The joint just above the amputation should have the full range of active motion, and above all, the stump

should be long enough so that the best appliance possible under the circumstances can be utilized.

In this country where artificial limbs have reached a very high state of development, owing to the large number of wounded as the result of the Civil War, a wooden socket is used. This is constructed of willow, covered with horse hide, and it is with this type of prosthesis in mind that the following recommendations are made.

UPPER EXTREMITY

The upper extremity from the prosthetic viewpoint provides a far greater problem than the lower, for there are no such standardized and satisfactory prostheses for the upper as there are for the lower extremity, so that no definite rules can be laid down for observance in amputating.

In the hand as much tissue should be left as possible, for all the limb maker can do is to produce something in the nature of a cosmetic result, except perhaps he may supply a hook to be worn, if the fingers are gone and manual labor is to be performed.

Amputation through the wrist does not usually make a good stump, for the styloid processes and articular ends of the bones are very apt to become tender and painful from the pressure and friction of the socket of an artificial hand. Amputation just above the styloids will give a shorter and far more satisfactory stump and yet will permit the wearing of just as useful an appliance.

In the forearm the general rule should be to save as much as possible up to a point 2.5 inches from the olecranon on the ulnar side. A stump shorter than this is of no use, as on flexion it ceases to exist as a stump anteriorly; the biceps tendon and the flexors of the forearm completely obliterate it, and push the socket of the artificial arm off.

An amputation through the elbow joint is unsatisfactory. It does not make a good bearing surface for the prosthetic appliance. It makes the artificial arm longer than the other, for the elbow joint of the artificial arm has to be at a lower level than the condyles of the humerus in order to get full flexion. Again, since through the condyles we have the greatest diameter of the arm, a wooden socket cannot be used, as all of it would have to be large enough to get by the condyles, and that would make it too large at the upper arm. Above the elbow we should save as long a stump as possible.

It may not be out of place here to mention the attitude toward arm appliances of our war veterans who have lost arms. All were given temporary arms on discharge from the army hospitals which they wore, for varying periods, to toughen the stump, for cosmetic purposes, raising morale, etc. When they appeared at Public Health Service offices for permanent arms, they practically unanimously requested mechanical arms, like the Cairnes, Dilworth and Miracle, with which the sleeve is filled out, which have a hand covered with a glove which looks quite natural, and which allows the flexion and extension of the fingers, and flexion and extension of the elbow. But after a thorough tryout many came back for a more simple apparatus, such as a hook, with which they could actually perform some manual labor, and which could be of assistance in their work. Of course for men who do not have to use their arms for heavy work, as office workers and professional men, the mechanical arm is the ideal one, as it can be used to hold light objects, and to manipulate a typewriter, for instance.

The important thing to remember in prescribing prosthesis for amputations in the upper extremity is that the remaining arm should be educated to its utmost, and the artificial arm should be used only as an aid. In most cases if an apparatus is furnished that has an interchangeable hook and hand, the latter for dress purposes, that is sufficient. It has been reported in recent literature that a large number of French wounded who had lost arms would not accept any artificial appliance whatsoever, but depended entirely upon their stumps.

THE LOWER EXTREMITY

In the upper extremity the stump serves as an anchor for an appliance, but in the lower, there enters in addition the very serious problem of weight bearing.

While the body weight is, to a certain extent, carried by all of the surface of the stump, yet certain parts of it are capable of carrying more than the other parts—and this apportionment of work for certain parts of the stump depends directly on the nature of the amputation. It is possible in certain cases to create a stump so that all of the body weight will be taken by its end—so-called "end bearing," and that is the ideal stump. However, a straight, end-bearing stump is only rarely obtainable and it usually requires substitution by utilizing the bony parts in the joint just above the amputation site. Such utilization of the bony parts together with the surrounding soft parts constitutes lateral bearing. A combination of end and lateral bearing may also be used.

The end-bearing type of stump requires no further description. While it offers a definite advantage, in that it gives a firmer hold on an artificial leg, yet in most cases no sacrifice should be made for it, as it is not essential. The amputation sites where end-bearing is imperative are in the Symes operation and through the knee.

In the lateral bearing stump the weight is borne, if in a thigh amputation, principally by the tuberosity of the ischium and the soft parts. In leg amputations, the weight bearing is taken by the lateral surface of the tuberosities of the tibia, and the upper part of the lateral surfaces of the tibia and fibula, but not the head of fibula.

THE FOOT AND ANKLE

Toes. A single toe should never be left, as it almost always becomes deformed, and offers difficulties when it comes to the wearing of a shoe. When all the toes are amputated, the best result is obtained by utilizing a plantar flap. The amputation completed, in most cases no further treatment is necessary, except an appliance such as a cork sole, to fill out the shoe. But some feet, owing to loss of the big toe and dropping of the anterior arch, may require arch supports.

The Chopart (mediotarsal) and Pirogoff (tibiocalcaneal) amputations are so whole-heartedly condemned by limb-makers, that they should, on general principles, be avoided. The objections are that at these sites, there is an unequal pull between the flexor and extensor tendons of the foot resulting in various deformities of the stump, usually equinus with tilting of the heel, and often complicated with pressure sores and tender areas. The prosthetic appliances required by these amputations are not only hard to fit, but they are clumsy and give rise to many practical difficulties. On the other hand there are many advantages in having the amputation site higher up, where excellent practical results can be obtained.

The tibiotarsal (Symes) amputation has caused more controversy than any other amputation. Surgeons on the whole are in favor of it, while artificial limb-makers generally condemn it. The disagreement is due to the fact that the operative result usually causes the artificial limb-maker a great deal of trouble.

Theoretically the Symes, if properly done, is an ideal operation, but in practice it often does not turn out as the surgeon wishes. Its success hinges mostly on one factor, that it be absolutely end-bearing, while what actually happens is that a tender scar, neuroma, displacement of the flap or other misfortune usually prevents the end of the stump from bearing weight.

If the stump turns out well and will bear weight, the ankle of the artificial leg has to be made thicker than the normal ankle, but as vanity plays as great a part in the maimed as in others, this forms a source of objection which the limb-maker cannot remedy, as making the ankle thinner will so lessen its strength as to make the limb dangerous to wear.

The surgeon will find it a good rule, unless he is particularly apt and skillful with the Symes, and the patient is willing to have the thick ankle, not to do this operation but to choose the higher site—the "point of election."

THE LOWER LEG

The ideal leg stump is one 6 to 8 inches in length; this is long enough to propel the artificial limb, can be fully flexed without the socket falling off, and the limb can be nicely tapered off, so that both ankles will look alike. There is nothing gained by having a longer stump, but instead there may be several disadvantages. For instance, in amputations lower down, the stumps are usually more poorly nourished, they have more of a tendency to ulcerate, are more affected by cold, and the scar is more liable to break open.

In cases where it is not possible to utilize as much as 6 inches of leg, an attempt should be made to come as close to it as possible, the minimum being the point where, on flexion to a right angle, the socket begins to slip off. The shortest effective stump seen was 1.75 inches below the lower border of the patella. This man can utilize his knee joint to its fullest extent in walking, and can sit with his knee flexed to a right angle.

In short leg stumps, it is advisable to remove the fibula, for the head of that bone in many cases is a source of persistent trouble. As the stump shrinks the head becomes more prominent; the socket rubbing constantly against the head causes the skin over it to become inflamed and tender, and the irritation may go so far as to set up a periosteitis.

THE KNEE

Above this point it is advisable to amputate at the knee joint, for even though very short stumps can be used as end-bearing in the flexed knee position, this is not advisable, owing to the frequent complication of bursitis, and the visible deformity at the knee in the apparatus.

Here again success depends on getting an end-bearing stump.

The ideal stump is the Stokes-Gritti, where the patella is left and placed in the depression between the condyles, but owing to the frequent mishaps in the operation, unless the surgeon is particularly

skilled in this technique he had better do a trans-condylar amputation, near the upper part of the condyles, removing the patella. If the cicatrices are carried high and posteriorly this should give an excellent result.

THIGH AMPUTATIONS

The rule in thigh amputations should be the same as in the arms. Save all you can.

After comparing the limbs in those that have had amputations through the thigh with those that have either a knee joint, or ability to carry weight at the knee, the first thought is "Could a lower amputation have been done?" While a thigh amputation with proper prosthesis gives a walkable limb, yet it is so inferior to amputations below or through the knee, that all measures should be attempted before sacrificing that joint.

If an amputation through the thigh must be done then, generally speaking, as much of the stump should be saved as possible. Speed states that however short the thigh stump, save it, rather than disarticulate. Even sawing through the neck of the femur gives a better and firmer base for the artificial limb than a disarticulation.

STUMP AFFECTIONS

The army has demonstrated the fact that an artificial limb cannot be worn too soon after an amputation; that the limb should be applied as soon as the stump can stand it, in many instances before the wound has entirely healed. If massage of the stump is started about 10 days after the operation, followed by bandaging with increased pressure, then hydrotherapy in the form of warm baths, hot packs, and contrast baths, and later with gentle pressure by the stump on a pillow with gradual increase in the amount of pressure, early weight bearing will be made possible. The reasons for having the patients walk early are that it raises morale, improves the general physical condition, and hastens shrinking and toughening of the stump.

Treatment of the various stump affections is the same as for similar lesions elsewhere, except that the wearing of the artificial limb should not be lost sight of. The longer the patient goes without his limb, the greater the tendency for the stump to become flabby, and consequently the longer the interval before he will be able to handle his artificial limb with any degree of facility and comfort. This is particularly true in the lower extremity and may be the cause of delaying their return to their occupations. In the after-treatment of stump affections, early walking is just as beneficial as after the original operation and for the same reasons.

Ulceration. This is the most frequent stump affection. The symptoms vary from being negligible to causing enough pain to prohibit the wearing of an artificial limb. The cause is either friction between stump and socket, mal-nutrition of short flaps with poor circulation, pressure of sharp corners on edges of bone, or local infection. In the treatment of this condition, an attempt should first be made to heal the ulcer without prohibiting the use of the artificial limb, but if treatment proves unsatisfactory, the stump should be put at rest. It may be necessary to excise the ulcer or even reamputate, in cases of painful, chronic ulcers associated with poor circulation, which prove recalcitrant to local treatment.

Enlargement of the stump. As a general rule, stumps atrophy after amputation, owing to loss of adipose tissue from the work they are put to in propelling the artificial limb, but not infrequently a stump will increase in size. This is usually due to the fact that the patient who has previously been engaged in some active occupation has now, owing to loss of a limb, taken up a sedentary vocation, and as a result has put on additional weight.

The remedy for this condition is to refer the patient back to the limb-maker for enlargement of the limb socket.

Stump swelling. This is a condition that comes on promptly in some stumps after the removal of the artificial limb, so that in some instances on awakening in the morning the patients are not able to get their stumps into the sockets. Several patients stated that they have had this overnight swelling for several years.

The treatment is to bandage the stump upon retiring. The Bender cotton elastic bandage is very efficient for this purpose.

Tender scars and neuromata. Until these complications cause enough pain to prevent the use of the artificial limb, the stump should not be molested, for should the subject be so unfortunate as to have frequent recurrences of these conditions it is easy to see where he may be laid up at frequent intervals.

It is sometimes possible to free adherent scars by physiotherapeutic measures, and so relieve the tenderness. Should this not help, resection of the scar must be done. The placing of the scar posteriorly to the stump at the time of the original and subsequent operations help in a large measure to prevent the tenderness.

The neuromata, if sufficiently painful to prevent walking, should be dissected out and severed

at as high a level as possible. Good results have been reported in preventing recurrences by the alcohol injections of these nerves after their severance.

If at the time of the original operation the nerves are divided at a higher level than the other structures, that will help to prevent the formation of painful neuromata. Then, should the nerves continue to grow, they are more likely to be lost in beds of muscle which serve as cushions and prevent pain on pressure.

Conical stump. This condition is most frequent in children, and is usually due to the growth of bone in the stump. The bone may become adherent to the scar, causing pain and ulcer formation. The treatment is reamputation. In adults a similar condition may be brought about by the flap being too short, causing retraction and shortening of muscles. The treatment is the same as for children.

Periosteitis (irritative). In some stumps due to irritation between the stump and the socket of the artificial limb, an inflammation of the periosteum may be set up. The diagnosis is made by ruling out other conditions and sometimes can be substantiated by X-ray.

The treatment is removal of the source of irritation, which means changing the socket, or going without the limb until the acute symptoms have subsided. In some stumps, if this condition is due to a thin flap, a reamputation may be necessary in order to get a thicker flap.

Exostoses. A proliferation of bone, usually from tabs of periosteum, giving rise to spicules in the end of a stump, may also be the cause of pain. The diagnosis is confirmed by X-ray. The treatment is the surgical removal of the proliferative processes.

Sinus. This is a fairly frequent complication. While in some instances it may be due to an osteomyelitic process, yet most of the cases seen had no bony etiological factor. The majority of these sinuses were in the middle of the scar. It is the writer's impression that they are caused by the too long-continued use of a wick for drainage purposes. Cotton thinks that often it may be due to sheer malnutrition from the mass of tough scar.

The treatment is surgical. If there is an osteomyelitic process present and the stump is long enough, reamputation is usually the more reliable and satisfactory method. If the sinus has no relation to bone and is at all chronic, complete removal of the sinus is the method of choice. The writer had occasion to see a woman 17 years after both legs had been amputated as the result of a railroad accident. One stump had healed perfectly, but the other had a persistent sinus which had been discharging pus since the amputation and which made walking uncomfortable. The sinus was resected; within 3 months the stump had healed, and now for 18 months has remained healed and symptomless.

If, at the time of the original operation, rubber dam is used for the wick and is inserted at the extremities of the incision and not kept in for more than 3 days, a non-osteomyelitic sinus should be a rarity.

Flexed leg stumps. This condition with rare exception is due to improper after-care. If, before the patient leaves the operating table, a posterior splint is applied and kept on until active motion is established and then early walking in an artificial limb prescribed, this complication will be avoided.

Since the first temporary limb can be used only for a relatively short time owing to the rapid changes which take place in a newly constructed stump it is advisable to construct a "home made" limb which will enable the patient to get up and around with all of its beneficial results. This limb can be made by making a cuff of plaster-of-Paris on the stump as far away from the end as possible (lateral bearing), and incorporating in it a double metal upright with a footpiece, or the army "pylon" can be used, which is a bifurcated wooden splint resembling a crutch. These are easily made, the patients can walk comfortably with them, and they also permit the dressing of the stump, should it be necessary.

Once the flexion deformity is established the treatment depends on several factors. If the patient can walk on a flexed stump and has no symptoms, and does not object to the evident deformity, then he should continue to do so. However, should the deformity be objected to or walking with flexed knee be painful, then either tenotomy, wedging or traction should be used, depending on the length of the stump, the length of time it has been flexed, and the condition of the joint. Once appreciating the value of the knee joint in locomotion, too many precautions cannot be taken to prevent this deformity.

SUMMARY

1. Do not lose sight of your patient after an amputation until a properly fitted limb has been prescribed and is worn. The sooner it is worn, the better.

2. Instruct patients that if at any later date they have pain, to return to you—and not to the limb-maker.

3. There are no standardized apparatus for stumps of the upper extremity. Generally speaking save as much as possible, avoiding joints.

4. On the lower extremity avoid the tarsal amputations—nothing is gained by using them, and there may be disagreeable complications.

5. The success of the Symes depends upon its being end-bearing; if doubtful about the outcome, amputate at the point of election.

6. The ideal site of amputation in the leg is 6 to 8 inches below the knee; try not to make the stump any shorter and there is nothing gained by having it longer—it may be detrimental.

7. In treating stump complications, it should always be borne in mind that the longer the patient goes without his artificial limb, the longer it will take him to become accustomed to wearing it again.

CORRESPONDENCE

TRUE AND FALSE KNOTS IN UMBILICAL CORD

To the Editor: Mrs. J. age 44, VI-para, reported her pregnancy early, as is the rule in our service here. Pregnancy was normal up to the thirty-eighth week, when the patient reported that there was absence of motion. Abdominal examination revealed motion, and also heart sounds could be elicited with the stethoscope. The patient thought there was undue "settling" but otherwise all was normal. Up to this time the movements of the fœtus had been more than usual, but they subsided now. However, the mother was satisfied that there was still movement.

Ten days later, I was called and after a normal labor, a male child was delivered, stillborn. The cord was around the neck twice, and had to be divided twice before the head could be delivered. No other interference was necessary; hence I call it a normal delivery.

There were four true knots and six false ones in the cord, which was normally long and of the usual size. The child had been dead possibly 2, or not more than 3, days, was perfectly formed, and normally developed. Save for the abnormality of the cord, the case was normal, and the mother made a normal recovery.

The case is of further interest, because the sister-in-law also lost a child the same way, but not in this service. This is the second stillborn child of this parent, but we have no history of the former case. I had never seen a case similar to this one, and therefore thought it worth reporting. The unusual activities of the fœtus no doubt caused the knots. The mother had lost a baby the second pregnancy before this one, and in this instance, had been particularly careful, as she desired another baby.

The Chinese say they never have such cases, and none has ever come under my notice. The specimen is in the Museum of the West China Union University.

WALLACE CRAWFORD, M.D.
Tzeliutsing, China.

A CORRECTION

On page 154 of the January, 1922, issue of SURGERY, GYNECOLOGY AND OBSTETRICS, in the report of the Hospital Conference of the American College of Surgeons in Philadelphia, the discussion on case records attributed to Dr. Edward A. Weiss of Pittsburgh should have been attributed to Dr. John D. Singley.

A. C. S.

EDITORIALS

SURGERY, GYNECOLOGY AND OBSTETRICS

FRANKLIN H. MARTIN, M.D.....Managing Editor
ALLEN B. KANAVEL, M.D.....Associate Editor

APRIL, 1922

THE SURGERY OF THE RIGHT BOWEL

THE early Egyptians understood the value of keeping the large bowel above reproach, for, as early as 1400 B.C., one may find directions for the preparation of enemata. It is possible they took their cue for this from the holy bird, the *ibis*, which was supposed to live forever. Of this bird Pliny in A.D. 77 wrote: "He washes the inside of his body by introducing water with his beak into the channel by which our health demands that the residue of our food should leave."

In the middle ages it was advised that places for defæcation be made warm and comfortable. In the seventeenth and eighteenth centuries scammony, with its griping and anal irritation, was the favorite drug; in the early nineteenth century, Abernethy with the everlasting "blue pill" mass and "black draught" came into vogue. Because of the misery these entailed, their use was abandoned and the intestines left to look after themselves.

Then came Metchnikoff, who tried so hard to make us believe that the entire large bowel is useless to the human race. Working along these lines, Lane with his brilliant surgery carried the profession almost off its balance. More sane judgment prevailed, and the poor old colon is not now sacrificed in the same ruthless manner.

There is a something in the right iliac region that passes for chronic appendicitis. This has been swallowed by the profession as an entity because there are recurring pain and tenderness often with nausea; there may or may not be constipation. A barium meal and X-ray examination shows retention in the appendix up to 100 hours. The tentative diagnosis is confirmed, the appendix is removed but the patient is not cured! Why? Because, while there is a fibrosed appendix from repeated irritation, this is not the whole trouble. In about 3 to 6 months, the patient returns with the same symptoms, only a bit more exaggerated, and a further examination together with the X-ray confirms the fact, already suspected, of adhesions. Another operation is advised and carried out, and the surgeon is surprised to find so many adhesions, which he tears and pulls apart. He did not look for them the first time, else the surprise would not be so great! Again the patient is well for a few months when those adhesions again form. What is the answer? Had the condition been gone into carefully in the first place one would have found that in addition to the pain, tenderness, and nausea, the patient was easily upset nervously, was in a general state of ill health, with so-called "indigestion," lassitude, drowsiness in the afternoon, loss of appetite, and that while there might be nausea at any time, it was worse in the early morning and was

not necessarily associated with the pain. A careful physical examination will, by careful palpation reveal a large, flabby cæcum that, just as one thinks he is about to grasp it, slips from under the examining hand. An X-ray examination, preferably enema, will show an absence of haustra in the cæcum and ascending colon, with retention in a cæcal pocket for days, although the bowels may evacuate daily. To clinch the diagnosis, an opaque enema is given and with the X-ray one sees the cæcum balloon and remain ballooned, and then the barium begins to flow through the ileocæcal valve. In one very pronounced case this enema was followed up the small bowel until a perfect duodenal cap was produced. As a rule, however, one must desist by the time the duodenojejunal junction is reached because of the discomfort produced.

How is the condition to be remedied? The removal of the appendix does no good. The reconstruction of the ileocæcal valve is of even less value! One may bear in mind that the cæcum in these cases approaches the herbiverous type of bowel, and that, therefore, some cases are benefited by eliminating meat from the diet. In order to change the bowel flora, a piece of a yeast cake may be eaten night and morning. Flaxseed added as an article of diet assists in securing daily bowel evacuations. Abdominal massage is of great benefit and when in the upright posture the wearing of an abdominal lift corset.

Failing to get physical efficiency in this way, in the early mild cases where the cæcum is still an abdominal organ, the removal of the appendix, combined with a plication of the cæcum, after dividing with sharp dissection a constricting band at the junction of the cæcum and ascending colon over the outer leaf of the mesentery, is probably all that is required. When the cæcum is a pelvic organ and is in a similar early stage of atony, the removal of the appendix, with cæcal plication and then a burying of the plicated margin into a slit in the posterior parietal peritoneum, serves a useful purpose.

In the advanced cases, where the appendix has been removed, and a series of adhesion-breaking, health-breaking, and heart-breaking operations have already been done, nothing short of a radical resection of the terminal ileum and cæcum, with an end-to-end anastamosis of the cut ileum to the ascending colon or to the hepatic flexure as the case may require, will be of any benefit.

There has been no mortality in the cæcal plication cases, nor has there been in the plication and implanting cases, and so far the results have been satisfactory.

In the resection cases, in 1920, we had twenty in which there were four deaths. Of these deaths two had developed fæcal fistulæ, and two others had developed colon infection in the wound. In the early months of 1921 we had 18 resections with one death, no fæcal fistula and two colon infections in the wound. We attribute the improvement in results to the use of a piece of rubber tubing at the site of the anastomosis. This is passed per rectum in from 5 to 17 days.

F. N. G. STARR

MYOMECTOMY

ABOUT 12 per cent of white and 30 per cent of colored women of 50 years of age have uterine myomata. Fifty per cent of colored women of 35 years who have not borne children have such tumors. Only a small proportion of women with uterine myomata have symptoms, and only myomata which cause symptoms require treatment, but all women who have myomata should be examined at intervals to see that the tumors are causing no harm.

The most common conditions indicating operation are those which result from: (1) hæmorrhage; (2) degeneration of the tumor (22 per cent); (3) malignant disease, usually carcinoma of the body of the uterus (4 per cent); 10 per cent of women more than 50 years of age who come to operation for uterine myoma have complicating malignancy; and (4) tumors causing pressure. The great majority of patients who have tumors extending above the pubes belong to this group. It has been shown that in 30 per cent of patients with myomata of the uterus which cause symptoms, the ovaries and tubes are seriously diseased, and often require operation independent of the myomata.

In about 5 per cent of our cases the diagnosis of uterine myoma was more or less clouded. A tumor of the ovary, either benign or malignant, was usually the cause of the failure of differentiation, especially when myomatous nodules, of no great consequence in themselves, were coincident in the uterus.

The use of the roentgen-ray and radium in the treatment of disease is in many respects most encouraging. In the treatment of myomata, radium has the advantage, containing, as it does, definite and measurable quantities of γ-rays which can be applied precisely.

One cannot escape the conviction that in cases of myoma the use of radioactive substances is a most destructive method of treatment, non-operative, it is true, but certainly not conservative. In the majority, if not all, of the cases in which rather large myomata disappear under their use, the patient loses the function of the ovaries, tubes, and uterus, although the non-functioning remnants are left in place to await an uncertain future. Many patients with small symptomless myomata are treated with radium on doubtful indications. Radium has a great field of usefulness in the treatment of myomata. For small tumors causing hæmorrhage in the menopause period, radium is the treatment of choice, and also for symptom-producing tumors in obesity and certain constitutional maladies, but its use has definite limitations.

Hysterectomy has been and still is the operation of choice for the greater number of symptom-producing myomata, and it has much to commend it. In patients more than 40 years of age, especially in whom the exact pathological condition is not established in every particular, exploration followed, if necessary, by hysterectomy is the prudent procedure. Supravaginal hysterectomy has a definite technique which has been so thoroughly and carefully worked out in the past 20 years that it has become the standard operation. Preserving the cervix renders the operation easier and safer, but the cervical remnant has no function and some unfortunate propensities. First, it leaves the patient with an average liability to cancer, and, second, it is usually the cause of those troublesome vaginal discharges called leucorrhœa, due to subsequent disease of the mucous glands of the cervix, and third, it may lead to greater vaginal shrinkage and tenderness. For these reasons, total hysterectomy, provided it can be performed without undue risk, is the better operation.

We have been able to save at least one ovary in about one-half of all the hysterectomies for myomatous disease. From the standpoint of conservation of the ovary, hysterectomy may be preferable to treatment by radium and the roentgen-ray, since if myomata are effectively irradiated the ovaries are destroyed. Acknowledging, as we must, the great benefits which have accrued to women through hysterectomy, we cannot blind ourselves to the physical and nervous changes which sometimes follow,

especially in young women. It would be interesting to know the percentage of divorces that have had their origin in this operation.

To one who takes a view of the whole situation, myomectomy must commend itself as a truly conservative procedure, and often the operation of choice. It has been urged against myomectomy that it is dangerous. From January 1, 1891, to November 1, 1921, 909 myomectomies were performed in St. Mary's hospital, with 7 deaths, a mortality of 0.7 per cent. Again it is said that other myomata may develop. In our experience only 2 per cent of patients came to hysterectomy later, and 60 per cent of these did not have recurrent myomata. We do not often perform myomectomy for patients more than forty. If conditions are such as to make the operation relatively safe, it is performed for patients from 35 to 40 years. It is performed for the majority of patients under 35 years, and for practically all under 30 years. Since symptom-producing myomata are much more frequent after the fortieth year, it may readily be seen that we have been conservative in choosing cases.

Myomectomy is more difficult to perform than hysterectomy, because the technique must be varied according to the character, situation, size, and number of tumors, but it does not present greater difficulties than can be easily mastered by the experienced surgeon. Twenty-three patients were pregnant at the time of operation; 7 of the pregnancies were ruptured extra-uterine, and 16 were intra-uterine. None of the patients died. The majority of patients with intra-uterine pregnancies following myomectomy went to term and were delivered of living children. When it is considered that in the latter group the tumors were degenerating and causing acute symptoms, and that in a large proportion indications of spontaneous emptying of the uterus were present at the time of the operation, it is remarkable that the disturbance subsided so often without premature expulsion of the child. In no instance in our experience with myomata complicating pregnancy have we been obliged to perform hysterectomy on the pregnant myomatous uterus with a non-viable child.

Five hundred four of our series of myomectomized patients are traced. Twenty-four had had one child since the operation, and seven had had two or more. Forty-three living children following myomectomy on 504 patients, only two-thirds of whom were married, is a strong argument for the conservative operation.

From this investigation of the actual results covering a period of 25 years it is evident that the operation of myomectomy has not received the attention it merits. We should make every effort to improve the technique and further the indications for the operation. It is the only truly conservative procedure for myoma of the uterus; an operation which removes the tumor and leaves the patient as she would have been had she never possessed it.

WILLIAM J. MAYO.

CONSERVATION OF THE GALL BLADDER

FOR some years there has been a growing tendency to remove the gall bladder in all cases where operation upon it is indicated and the condition of the patient as a surgical risk does not contra-indicate it. The reasons for this are plausible but not convincing. Has not the enthusiasm of the surgeon in favor of radical treatment got the better of his surgical judgment and caused him to overlook the just demands of the gall bladder for conservative treatment?

One surgeon of great experience writing in 1913 said: "Cholecystostomy is the operation of choice because it saves this valuable organ for future function," but in 1921 he reverses his position when he writes: "Cholecystectomy has taken the place to a large extent of cholecystostomy because of the well-known fact that the gall bladder following cholecystostomy is a liability rather than an asset to the patient." So, Mayo-Robson protested against the indiscriminate removal of the gall bladder, asserting that cholecystostomy is "unquestionably the operation to be aimed at in the greater number of cases of cholelithiasis," and Moynihan said: "The majority of surgeons will agree with Maurice Richardson that 'the end-results in cholecystostomy are certainly as gratifying as end-results have ever been in any class of abdominal operations.'"

Is it not worth while considering that the profession may have gone too far and would it not be more reasonable to adopt that attitude, as in other departments of surgery, where surgical judgment counsels that each case be decided on its merits with the desire to do nothing in excess?

The reasons for radical practice are obvious. It is claimed that simple drainage is not curative, relapses occurring far more frequently than after removal; that after cholecystectomy the ducts dilate, thus compensating for the loss of the gall bladder, and the system adapts itself to the changed conditions; that in nearly all cases of cholecystitis there is associated hepatitis and, quite frequently, pancreatitis, due to invasion through the lymphatics (Deaver, Graham, Judd), and that the best way to cure these conditions is to remove the gall bladder, the seat of infection; that once infected, the gall bladder cannot be cured by drainage, owing to the imbedded infection in the deeper layers of the organ, and that it should, in all cases of disease, be treated like the appendix and be removed. In other words that the gall bladder is a useless organ and should be removed whenever the surgical risk justifies it.

"The fact that few ills follow upon removal of the normal gall bladder means merely that the body has adapted itself to the loss, not that the loss is unimportant. In this connection the surgeon would do well to remember that uncertainty as to function and confidence in readjustment are at best questionable motives for adventures in ablation." (McMaster and Rous.)

The gall bladder should *not* be placed in the category of the appendix; it is not a vestigial organ, but has a distinct function which should be maintained where possible. It not only acts as a backwater to relieve the tension of the steady down-pouring of bile, but as an intermittent reservoir for a fluid which is needed in the duodenum to assist in pancreatic digestion by neutralizing the acid chyme, and which is supplied at just the right time, by virtue of that beautiful mechanism, which inhibits the sphincter of Oddi at the same time that the gall bladder is stimulated to contract.

This storage function is made more evident by the recent work of McMaster and Rous, showing that the capacity of the organ is greatly increased by its inspissating power on the bile. "The restriction of the concentrating activity to the gall bladder is good evidence that the latter has special significance for the organism." (McMaster and Rous.) Furthermore, admitting that in every case of cholecystitis there is associated infection of the liver, has it been conclusively shown that drainage may not relieve, not only the gall bladder, but the liver as well? Does not this predilection for removal of the gall bladder tend to warp surgical judgment and lead

to the useless sacrifice of gall bladders that might be saved? Murat Willis, calling attention to the report of 397 cases in the Peter Bent Brigham Hospital, in which only 50 were non-calculous, deplores the fact that, of these 50, 16 were normal gall bladders; so that 1 patient out of 3, subjected to cholecystectomy for "simple cholecystitis parted with a normal gall bladder," the failure of the patients to obtain relief, "confirming the belief that the diagnosis of cholecystitis was a faulty one."

Instead of saying, then, that the gall bladder should be removed except when contraindicated by the operative risk, would it not be better to reverse the formula and say, the gall bladder should only be removed on account of definite crippling pathology which will preclude restoration to useful function? The removal of the gall bladder changes physiological relations, which should never be done without adequate reason. From the time of Sir William Ferguson conservative surgery has had a recognized place and our striving should be to prevent unnecessary mutilation. Other organs have been removed without apparent detriment, but such removal without justification is crippling and should be discountenanced.

F. W. PARHAM.

TRANSACTIONS OF SOCIETIES

CHICAGO SURGICAL SOCIETY

REGULAR MEETING HELD DECEMBER 2, 1921, DR. DEAN LEWIS, PRESIDING

THE DIAGNOSIS AND TREATMENT OF SOME COMMON INJURIES OF THE SHOULDER JOINT

DR. ROBERT W. LOVETT, Boston, Massachusetts, read a paper, by invitation, on the diagnosis and treatment of some common injuries of the shoulder joint. (See p. 437.)

DISCUSSION

DR. JOHN RIDLON: I am glad to take this opportunity to admit that the difficulties encountered in treating injuries to the shoulder joint have always been more troublesome and more obscure to me than those in treating all the other joints put together. It has been a great satisfaction to me to hear a reasonable exposition of the conditions such as we have heard from Dr. Lovett.

DR. EDWIN W. RYERSON: Two points struck me very forcibly in this paper: first, the question of neuritis. I am beginning to believe that there is no such thing as a neuritis of the shoulder, a neuritis of the sciatic nerve, or a neuritis of the lumbar region, so-called lumbago, except in those cases where metallic poisoning or alcohol has had something to do with it. I believe they are dependent upon some other condition. About 6 years ago, when Codman's work was penetrating through my intellect, I saw a woman who had a most intense and terrific pain in the right shoulder. Treatment with heat and all other means that could be used for it gave no relief. Distinguished neurological consultants saw her and advised the actual cautery, which was applied, but it gave no relief and even made the pain worse. An X-ray picture showed a deposit in the region of the subdeltoid bursa, and after a few days more of great suffering she consented to have this opened, which I did through the deltoid muscle. The bursa was about the size of a silver half dollar and was completely filled with fine calcareous material which, when rubbed between the fingers, gave the impression of little sharp crystals. We are now told by some writers on this subject that this was probably not in the subdeltoid bursa but in the supraspinatus tendon sheath. I do not believe that. I believe it was a definite affair in the subdeltoid bursa. Cases of this kind need operation. It is perfectly true that under conservative treatment, especially with an abduction splint, the deposit in the subdeltoid bursa may disappear with considerable rapidity, but in this case, operation was undoubtedly indicated.

A second point which I think ought to be mentioned is the fact that a subacute arthritis is very apt to occur in the shoulder joint. It may be rheumatoid or osteoarthritic in its nature, and is more common than Dr. Lovett has indicated in his paper. This, of course, has to be treated along general medical and surgical lines.

The lesions of the supraspinatus tendon are interesting. I saw a gentleman a few weeks ago who in making a backhand stroke in playing tennis felt something crack in his shoulder, and an X-ray picture showed that a piece of bone at the insertion of the supraspinatus tendon was pulled loose. He got well in 2 or 3 weeks with an abduction splint.

Dr. Lovett emphasizes the importance of putting up these cases in abduction. No one should forget to do this in the somewhat obscure cases of shoulder-joint lesions we see. It is comfortable except from a cosmetic standpoint, but there are some of these cases that should have the arm put up in that way, instead of simply at the horizontal plane, although that is much more comfortable.

DR. D. B. PHEMISTER read a paper entitled "Hematogenous Staphylococcus Infections in Various Organs Secondary to Skin Foci."

GROSS PROBLEMS FOLLOWING OSTEOMYELITIS OF ADOLESCENT LONG BONES

DR. KELLOGG SPEED read a paper entitled "Gross Problems Following Osteomyelitis of Adolescent Long Bones." (See p. 469.)

DISCUSSION

DR. JOHN RIDLON: I think a word might be said about simple fractures involving the epiphysis and the nutrient artery region, lest it be assumed that simple fractures may result as do infected fractures.

I have broken many bow legs, entirely disregarding the nutrient artery of the tibia, choosing the most favorable place to break the bone, and have never seen arrested growth from such a break. I have broken the lower end of the femur as low down as possible many times for knock-knees, ignoring the epiphyseal line, and I have also deliberately in a few cases taken off the lower epiphysis of the femur for the correction of knock-knees, and

in none of these has there been any arrest of growth. The law regarding simple fractures obviously is not the same as the law that must be regarded in the infected fractures.

DR. E. WYLLYS ANDREWS: In the pathogenesis of arrested growth from epiphyseal injuries, as Dr. Ridlon and the reader of the paper both stated, infection plays a very imporant part, but not absolutely a necessary part.

The occurrence of arrested growth after a simple fracture of the epiphysis is very rare, but I have seen it in two cases. Both of these cases were called to my attention sometime afterward on account of the occurrence of extraordinary deformity, which was the cause of a lawsuit for damages. It is appalling to think that so simple a thing as a simple fracture of the lower end of the ulna, or radius, or tibia, or any of the bones where there are tears, can be violently injured, relieved by proper reduction, with apparent recovery, and then years afterward result in a tremendous unsightly deformity. That is what happened in the case of one of my colleagues, and the part that was appalling was that we could not find anything for a long time in the literature to justify the grounds of defense we were trying to work out for the purpose of exonerating the practitioner from all blame. Both of the cases I have seen happened in the forearm. Both of them had the forearm set, and the arm remained for some years apparently perfectly well until the development of an extremely bad deformity. In both cases damage suits resulted.

In trying to arrange for a defense in the cases involved we accumulated a tremendous lot of reprints and made an extensive research of the literature, but we found the question very inadequately discussed. The paper we have had tonight is perhaps almost pioneer in this field.

DR. HARRY E. MOCK: The pictures shown by Dr. Speed of the active growth in the upper epiphysis of the fibula is well illustrated in amputation cases. In amputating the lower leg in children this fact should be borne in mind. In the last two years in at least ten or twelve cases of old amputations in children from the Spaulding School, I have seen a projection of the fibula beyond the stump, requiring secondary amputation. This bone has a more active growth than the tibia itself, and, in amputating, that fact should be considered. The bone should be removed completely in high amputations or removed from 2 to 3 inches higher than the tibia level.

DR. DENNIS R. CRILE: While the growth in length in the tibia, fibula, and radius occurs both in the distal and proximal ends, such growth in the ulna occurs at the distal end. The anatomical arrangement is such that the sigmoid cavity butts against the lower end of the humerus at a point distal to the epiphysis, so that growth from the proximal epiphysis does not lengthen the bone. This explains in some measure why we get such extreme overgrowth at the lower end of the ulna. The rate of growth of each epiphysis of the radius is only half the rate at which the ulna normally grows from its distal end alone. For this reason I believe that destruction of the distal ulnar epiphysis will result in permanent shortening of the ulna, while damage of the proximal epiphysis of the ulna will make very slight difference in the length of the ulna. That I think is an anatomical fact worth remembering. Excision of a section of ulna above the epiphysis corrects the condition without introducing the element of later deformity.

DR. SPEED (closing): There is much discussion in comparative anatomy on the point mentioned, especially in relation to the blood supply, and I know of course the fibula is an exception to the epiphyseal law, and I so stated in my paper. I tried to narrow the subject down to acute inflammatory conditions. I have seen two cases of epiphyseal separation with stoppage of growth after a fracture. There are certain more remote biological points I did not go into but viewed the matter from a purely clinical standpoint.

AMERICAN COLLEGE OF SURGEONS

FEBRUARY MEETINGS OF STATE SECTIONS OF THE CLINICAL CONGRESS OF AMERICAN COLLEGE OF SURGEONS

GROUP meetings of the American College of Surgeons were held during February in five group centers: Lincoln, Nebraska; Kansas City, Missouri; Los Angeles, California; Houston, Texas; and Memphis, Tennessee.

The meetings carried the usual two-day program: clinics in the forenoons of two consecutive days, hospital conference the afternoon of the first day, public gathering the same evening, and the scientific session the afternoon of the second day.

The speakers from the central office were Dr. Franklin H. Martin, director general of the College; Dr. George W. Crile, a regent of the College; Mr. T. E. Allen; and Mr. R. I. Raymond. The Rev. C. B. Moulinier, S. J., president of the Catholic Hospital Association, attended and addressed all meetings.

Meetings in Lincoln for the states of Iowa, Nebraska, and South Dakota, were held February 6 and 7, under the chairmanship of Dr. A. R. Mitchell of Lincoln, at the Lincoln Hotel and at the City Temple Auditorium. There were 76 Fellows in attendance and the local clinics were well filled. About 250 attended the hospital conference, 1,000 were present at the public meeting, and approximately 200 met at the scientific session.

The meetings for the Missouri and Kansas sections were held February 9 in Kansas City at the Baltimore Hotel and the Grand Avenue Temple. Dr. Daniel Morton, counselor, presided in the absence of Dr. John F. Binnie, chairman.

The clinics carried heavy programs and were well attended. About 125 Fellows were present at Kansas City, and their number was heavily reinforced by the attendance of the local medical fraternity. There were about 400 present at the hospital conference, a good gathering at the public meeting, and about 250 at the scientific session.

The group meeting for Arizona, California, and Nevada was held February 17 and 18 in Los Angeles, under the chairmanship of Dr. Stanley Stillman. The work of the local committee was facilitated by the convenient arrangement of having all meetings in the Alexandria Hotel, where sufficient accommodations could be afforded.

One hundred and twenty-two Fellows were in attendance. The College had the pleasure of entertaining Judge Harold M. Stephens of Salt Lake City, who spoke at both the hospital conference and the public meeting.

The hospital conference drew nearly 350, the public meeting about 900, and many were turned away. The scientific session was attended by more than 400, many of the local surgeons and doctors being present.

The Houston meeting, February 23 and 24, included the sections for New Mexico, Oklahoma, and Texas. Dr. Bacon Saunders presided.

Ninety-four Fellows were in attendance, and at this group meeting the College had the cooperation of the Harris County Medical Society. This co-operation, as was evidenced at the St. Paul meeting in January, proved a helpful arrangement and one desirable to have hereafter wherever possible.

The clinical meetings in the forenoon of both days had an unusually good attendance, doubtless due to the participation of the members of the Harris County Society.

The hospital conference was fortunate in being addressed by Mr. Robert Jolly, superintendent of the Baptist Hospital, of Houston, whose inspirational talk to the hospital people was of notable value. About 200 attended.

The public meeting was held at the First Presbyterian Church, and the speakers had the pleasure of addressing a thoroughly packed house of about 1200.

The scientific session was attended by more than 200, including a large number of the Harris County Medical Society.

The Tennessee, Kentucky, and Arkansas sections met in Memphis, Tennessee, February 27 and 28, under the chairmanship of Dr. W. A. Bryan. The activity of the local committee here was particularly evident in drawing out an excellent attendance to the meetings under un-

favorable weather conditions. One hundred and seventeen Fellows were registered in Memphis.

The hospital conference at the Chisca Hotel, in addition to the regular speakers, listened to an address by Dr. W. R. Bethea, in which he covered the necessities of hospital administration and very excellently interpolated the use and value of the hospital standardization program.

The public meeting was held at the Goodwyn Institute, where an audience of about 800 gathered. The scientific meeting was held at the Gayoso Hotel with 250 present.

The above necessarily brief résumé is altogether inadequate to present the effective activities of the local and sectional committees and the cordial interest of the local physicians and surgeons. Least of all does it convey the widespread interest on the part of the general public in the work of the College in the standardization of hospitals and scientific medicine.

It is increasingly evident that the state executive committees are effectively intent in thorough organization within their own states and are helpfully co-operative one with another in the group meetings under the auspices of the committee for the host state. When the difficulties of travel, hotel reservations, location of headquarters and meeting places for committees and open meetings are all taken into consideration, it is remarkable with what smoothness the machinery of these large meetings, covering such wide range of territory, has operated.

No less commendation is due the local committees in the cities entertaining the sections. It has been the usual experience that every facility to lighten the necessary burdens of these gatherings has been provided long before the arrival of the Fellows of the College and the representatives from the central office.

A significant and helpful feature throughout has been the presence and interest of the local physicians and surgeons who are not members of the College. It is evident that the meetings have in some definite measure fulfilled their obligation of carrying the message of the College to them.

It is the purpose of the group meetings to present hospital standardization to all the hospital people who may be brought to them; and certainly a large measure of commendation is to be accorded the trustees, superintendents, staff members, internes, and nurses who have availed themselves so interestedly of the message of these meetings.

An element of increasing importance in the sectional gatherings is the presentation to the public of the definitely three-fold program: hospital standardization, the aims of the college toward the furtherance of best surgical service to the public and the safeguarding of public health, and, lastly, the place of scientific medicine and the need for the co-operation of the laity in its furtherance.

That these points already are of general interest to the citizens of these fourteen states is indicated by the voluntary lay attendance at the public gatherings. Their interest has been not one of curiosity but of definite search for information. It is evident that the public is anxious to know more of hospital betterment in order to utilize this information; it is interested in scientific medicine in order to avoid unscientific medicine, and to assist with its influence in the furtherance of real research at the cost of sentimental prejudice.

The labors of the College as presented to the laity have evidently won for the College and for its program a permanent and understanding appreciation. It is to be hoped that this appreciation will express itself in the furtherance of the College program for the safeguarding of public health through local, civic, county, and state lay organization. Definite work toward this end is much to be desiderated, both through the suggestion as to the objects that may be accomplished by the laity and the methods, possibly, through which organization to this end may be effected in a purely civic way.

SCHEDULE OF SECTIONAL MEETINGS FOR 1922

Pennsylvania, Delaware, and New Jersey at Allentown-Bethlehem, Pennsylvania, April 3-4.

Quebec at Montreal, Quebec, May 11-12.

New England States at Portland, Maine, May 15-16.

Nova Scotia, New Brunswick, and Prince Edward Island, at Halifax, Nova Scotia, May 19-20.